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NASA CR-
144442

FINAL REPORT
1975

IMAGE 100 PROCEDURES MANUAL DEVELOPMENT

APPLICATIONS SYSTEM LIBRARY DEFINITION

AND

IMAGE 100 SOFTWARE DEFINITION

Contract NAS-9-14556 and Contract NAS-9-14557

(NASA-CR-144442) IMAGE 100 PROCEDURES MANUAL DEVELOPMENT: APPLICATIONS SYSTEM LIBRARY DEFINITION AND IMAGE 100 SOFTWARE DEFINITION Final Report (Texas A&M Univ.) 256 p HC $8.50 CSCL 05B G3/43

N75-32573

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TABLE OF CONTENTS

I. INTRODUCTION

The G. E. Image 100 System provides the framework around which to build a versatile tool for the development, testing, and evaluation of image analysis techniques used in support of current and future Earth Resources Programs. In order to effectively support current applications, the existing Image 100 System requires augmentation through the acquisition of additional hardware, the design and implementation of application-oriented software, and the development of procedural guidelines for efficient System utilization and management.

An augmentation plan for the Image 100 System should be developed to provide the following capabilities:

- A batch-processing mode for testing the effectiveness and applicability of newly-developed data analysis algorithms and techniques.
- A means whereby interactive image analysis techniques, which are directly applicable to Earth Resources data-processing requirements, can be developed.
- A means whereby data-analysts and analyst-interpreters can effectively interact.

Developmental work aimed at providing the above capabilities can be divided into the following general areas and associated tasks:

Procedures Manual Development

Tasks

1. Procedures Manual Outline
2. Development of the Procedures Manual by completing each section of the outline

Operating System Development (RSX 11D)

Tasks

1. Implement Operating System which provides batch/conversational and interactive modes
2. Maintain Operating System
3. Modify Operating System to accomodate advanced file-handling techniques

Image Analysis Library Development

Tasks

1. Identify computer programs which should be part of the Image Analysis Library
2. Document, prioritize implementation of, and procure programs for Image Analysis Library
3. Design Library programs so that they can be used effectively in interactive mode
4. Implementation of Image Analysis Library
5. Maintain Library

Interactive System Development

Tasks

1. Augment Interactive System which operates under Operating System (RSX 11D) with minimal modification of Operating System
2. Augment advanced file-handling capability for both batch/conversational and interactive modes
3. Interface with personnel developing Operating System

4. Maintain/Modify Interactive System
5. Study hardware/software configuration for advanced operational system

Interactive Capabilities Development

Tasks

1. Determine those interactive capabilities needed to support various Earth Resources Projects (LACIE, FAP, etc.)
2. Implement software to provide interactive capabilities under Interactive System using Image Analysis Library

II. SUMMARY OF WORK PERFORMED

The work performed under the subject contracts is a portion of that described in the Introduction--Procedures Manual Development and Image Analysis Library Development, namely;

- Preparation of an Image 100 Procedures Manual Outline
- Identify and prioritize implementation of computer programs essential to earth resources data processing requirements (FAP, RAP, LACIE, RT&E, etc.)

The outline of an Image 100 Procedures Manual was developed which sets forth guidelines, of both a general and specific nature, that provide a basis for the preparation and updating of an Image 100 Procedures Manual. The scope of the outline was limited to definition of general features of a procedures manual together with special features of an interactive system. The outline is organized in a

"task to be performed" fashion, and the topical order is intended to be a logically ordered "table of contents." This work is discussed in more detail in the next section and Appendix A.

Computer programs were identified (source, purpose, availability, application, etc.) which should be implemented as part of an applications-oriented library for the Image 100. In addition, each identified program was assigned an implementation priority. Although the Image 100 System is an interactive system that will also operate in the batch mode, identification of computer programs was based only on the requirement that they be utilized in the batch processing mode. Computer program identification was limited to those having direct or anticipated application to earth resources data processing requirements. It should be noted that many of these programs are essential to the development of interactive data processing capabilities not currently available on the Image 100 System. The Image Analysis Library is discussed in more detail in Section IV and Appendix B.

III. PROCEDURES MANUAL DEVELOPMENT

This portion of work is concerned with developing an outline of a Procedures Manual for the Image 100 System. By Image 100 System we mean the PDP 11/45 general purpose computer, special image analysis hardware (the G.E. Image 100) and all associated software. Even though the scope of this task is mainly limited to the development of a Procedures Manual outline, we did author those sections

dealing with updating standards, program documentation standards, and library documentation standards. Also, we authored a JCL Cookbook for FORTRAN IV users.

The purpose of a procedures manual is to provide information necessary to effectively use the system. This includes descriptions, operating procedures, maintenance procedures and so on (much of which is furnished by the manufacturers of the hardware), but must also include standards for documentation, maintenance and augmentation of system hardware and software. We feel that work performed in furnishing suitable documentation for a given program is more than offset by the long term reduction in effort in use of the program. Thus we pay particular attention in this outline to setting a flexible but high standard for documentation for programs at each developmental level.

In formulating documentation standards, an effort was made to utilize existing widely-accepted documentation guidelines. While not properly a part of a procedures manual, the information we located may be of use to some programmers in their attempt to understand and follow the standards for documentation set here. We found the following documents to be particularly helpful:

NASA Handbook, NHB 2411.1 July 1971
"Computer Program Documentation Guideline"

Goddard Space Flight Center, X-540-72-114 Feb. 1972
"A Programmer's Guide to the Goddard Space Flight Center Computer Program Library"

DOD Manual 4120.17-M Dec. 1972
"Automated Data System Documentation Standards Manual"

Some sort of committee or working group should be formed to decide what is acceptable (well-documented, tame) enough to be implemented into the Image Analysis Library or into the Interactive system. At the present time, the Image Analysis Library is a collection of forms which identify programs of possible use and a list of functional requirements. As a useful program is located and implemented, it can pass through the following stages:

1. Identified (by a Computer Program Identification Form)
2. Compatible Library Unit (card deck and documentation of a program compatible with the PDP 11/45 system)
3. Specially-designed Library Package (a collection of compatible units assembled into an efficient package)
4. Implemented Library Program (a completely documented program of general interest with object code kept on the system disk)
5. Interactive Unit

Library management information in the Goddard manual mentioned above may be a little elaborate for the Image Analysis Library, but it has not been ignored. However, we feel it would be premature to set final management standards for a library which does not yet exist.

IV. IMAGE ANALYSIS LIBRARY DEVELOPMENT

This portion of work is concerned with the identification of, and establishing implementation priority for various software units which will comprise an Image Analysis Library to support Earth Resources data processing requirements. By Image Analysis Library

we mean a collection of both general-purpose mathematical/statistical routines and special-purpose data-analysis/pattern recognition routines.

The Image Analysis Library has been partitioned, functionally, into the four libraries (and further into packages) as outlined in Appendix B. Identification forms were completed for various computer subroutines and programs and subsequently arranged by Package (See Appendix B). These completed forms represent an initial attempt at defining those routines which will eventually comprise an Image Analysis Library for the PDP 11/45. Care has been taken to insure that the identified programs represent what is generally thought of as the best available technique for performing a particular function. In a number of cases, several theoretically equivalent computer programs were available with minor to extensive variations in code. We have exercised our technical judgement in an attempt to minimize duplication among the programs appearing in Appendix B.

In some cases a particular functional requirement appears for which no computer program has yet been identified. In those cases we have tried to indicate where such programs can be found and identified by the individuals who have either developed or are developing the programs.

Each subroutine or program which has been identified is assigned an implementation priority according to the following priority definitions:

Priority I - Basic utility subroutine or program required for the implementation of existing image analysis techniques

Priority II - Existing image analysis techniques (requires majority of Priority I items)

Priority III - Subroutine or program required to support development and/or refinement of image analysis techniques

Priority IV - Image analysis techniques in research and development stage.

APPENDIX A

PROCEDURES MANUAL OUTLINE

COMMENTS ON PROCEDURES MANUAL OUTLINE

COMPLETED SECTIONS OF PROCEDURES MANUAL

PROCEDURES MANUAL OUTLINE

A. Hardware Documentation

1. Hardware configuration
2. Hardware description by unit
3. Updating standards

B. Maintenance

1. System log standards
2. System manager's guide
3. Hardware
   a. Installation
   b. Check list
   c. Preventive maintenance
   d. Failure
      (1) failure report forms
      (2) check list of repairs in progress
4. Software
   a. System software
      (1) software performance summary
      (2) software problem report form
      (3) filing and updating standards
   b. Batch and conversational library
      (1) software performance summary
      (2) software problem report form
      (3) filing and updating standards
   c. Interactive software
      (1) software performance summary
      (2) software problem report form
      (3) filing and updating standards
   d. Software failure bulletin board

C. System Software Documentation

1. Overall system concept
2. System programs
    a. DOS Monitor
    b. BATCH - 11
    c. FORTRAN IV
    d. LINK - 11 Linker
    e. LIBR - 11 Librarian
    f. PIP File Utility Package
    g. MACRO - 11 Assembler
    h. EDIT - 11 Text Editor
    i. ODT - 11R Debugging Program
    j. Others
3. Cookbooks
    a. Job control language - BATCH
    b. IMAGE 100 orientation
4. FORTRAN conversion problems
5. Concise summary of all error messages issued by system programs
6. Other system software
7. Updating standards

D. Library Documentation

1. Program documentation standards
    a. Batch and conversational
    b. Interactive special functions

2. Image Analysis Library

   a. Pre-analysis data processing library

   b. General mathematical library

   c. General statistical library

   d. Pattern recognition library

3. Interactive special functions

4. Updating standards

E. Interface

1. Interface documentation standards

2. Interface documentation by hardware unit

3. Updating standards

COMMENTS ON PROCEDURES MANUAL OUTLINE

COMMENTS ON PROCEDURES MANUAL OUTLINE

In the development of this procedures manual outline, we tried to be as concise as possible. We make the following comments to guide efforts to supply the necessary information. In some instances, we were able to identify manuals which partly supply this information. Additional manuals and information, particularly relating to hardware maintenance and system software documentation, exist and need to be identified and adapted to fit the existing system configuration.

Documentation of hardware appears in the outline under major divisions A, B and E, as follows:

under A (Hardware Documentation), for each unit

1. General description
2. Detailed physical description
3. Power requirements
4. Operating environment
5. Normal operations
6. Principles of operation
7. Block diagrams
8. Electrical diagrams
9. Accessories

under B (Maintenance)

1. Unpacking and incoming inspection
2. Installation
3. Warranty information
4. Initial checkout procedures

5. Tools and test equipment required

6. Preventive maintenance (daily, weekly, quarterly, annually)

under E (Interface)

1. Initialization

2. Interface design

3. Interfacing procedures

4. Timing

5. Data flow

6. Control panel interface

7. Data lines

8. Code charts

9. Diagnostics

10. Hardware dependent software

Documentation of programs appears in the outline under major divisions B, C and D. By "program" we refer throughout this outline to all types of subroutines, functions, programs, program packages, utilities, compilers, subsystems and systems. Maintenance of programs is described in B, system programs are documented in C (System Software Documentation) and user created (library) programs are documented in D (Library Documentation).

Software other than programs or program documentation is represented throughout the outline. Hardware operations manuals appear in A, diagnostic software is documented in E, system operation and management information appears in B and initialization procedures for system programs and other software procedures are described in C.

Procedures manual management information is spread throughout the manual, mostly in the form of documentation and updating standards.

While a reference copy of the entire procedures manual should be kept on file, it is clear that some elements need to be located where they can be more easily referenced. Documentation standards for the use and maintenance of a system library are set in D.

A. System Hardware Documentation

1. Hardware configuration (general description)

a. Overview of hardware with floor plan

b. Processor (including size of internal storage, cycle time)

c. Storage media (tape units, disk units)

d. Output devices

e. Input devices

f. Special Image Processing Hardware

2. Hardware description by unit

3. Updating standards

B. Maintenance

1. System log standards

These standards specify what is to be kept in the system log, the frequency of entries, and those personnel required to make and review entries.

2. System manager's guide

DEC manual DEC-11-OMGRA-A-D (BATCH-11/DOS-11 System Manager's Guide) provides information needed to install and manage the operating system. Modifications in the operating system necessitated by special interactive requirements must be documented here. Non-standard system modules (device drivers

and EMT's) should be described here.

3. Hardware (by unit)

   a. Installation

      This section includes information on the installation and acceptance of the hardware unit; also included is information on warranty, service contracts and general time-limited service.

   b. Checklist

      By this we intend a quick check of the status of the system hardware which can be gone over (say) with each change of shifts.

   c. Preventive maintenance

      A daily, weekly and so on schedule of preventive maintenance should be established and followed by operations personnel.

   d. Failure

      (1) failure report forms

      The failure report procedures currently in use appear to be based on those developed for a much larger and more general maintenance problem. It appears that time could be saved and quality control improved if a modification of the current form were made to accommodate the special needs of the Image Processing Lab. One form, the WITHOLD tag (Form 1055), seems to be quite effective.

      (2) check list of repairs in progress

      This list, now kept in the form of a bulletin board, should include parts on order, special equipment

or personnel required, the interim status of the system and so on.

4. Software

The DEC document entitled Software Performance Summary contains an extremely attractive and easily maintained system for reporting, correcting, filing and updating software problems. We strongly recommend their method replace the current method in system software problem reporting, and that an adaption to the needs of the Image Analysis Library interactive software be made.

a. System software

(1) software performance summary

(2) software problem report form

(3) filing and updating standards

b. Batch and conversational library

(problems in the Image Analysis Library and associated documentation)

(1) software performance summary

(2) software problem report form

(3) filing and updating standards

c. Interactive software

(problems in the interactive software and associated documentation)

(1) software performance summary

(2) software problem report form

(3) filing and updating standards

d. Software failure bulletin board

Here we suggest the establishment of an informal bulletin board to alert all system users of software failures which have been noted. When a way to avoid the problem is known it may be included. Although this information may also be included in a.-c. above, it seems unlikely most system users would keep up with that rather formal documentation. The minor duplication of effort involved is negligible compared to the benefits.

C. System software documentation

As we view the present system configuration, essentially all system software is supplied by DEC. We identify here major components of system software and make a few suggestions for easier use of the system. We also suggest an Image 100 orientation manual.

1. Overall system concept

(A general description of system architecture)

2. System programs

In each of the system programs mentioned here, we have been able to identify a programmer's guide (a DEC document) but not the actual program documentation. For example, the FORTRAN IV compiler programmer's manual contains almost no information on how the compiler itself operates. The Procedures Manual should contain such material when it is available.

a. DOS Monitor (Disk Operating System Monitor Programmer's Handbook, DEC-11-OMONA-A-D)

b. BATCH-11 (BATCH-11 Users Guide, DEC-11-OBUDA-B-D)

c. FORTRAN IV (PDP-11 FORTRAN IV Compiler and Object Time System Programmer's Manual, DEC-11-LFIVA-A-D)

d. LINK-11 Linker, and

e. LIBR-11 Librarian (BATCH-11/DOS-11 Linker (LINK 11) and Librarian (LIBR-11), DEC-11-ULIMA-A-D)

f. PIP File Utility Package (BATCH-11/DOS-11 File Utility Package (PIP), DEC-11-UPUPA-B-D)

g. MACRO-11 Assembler (BATCH-11/DOS-11 Assembler (MACRO-11), DEC-11-OMACA-B-D)

h. EDIT-11 Text Editor (BATCH-11/DOS-11 Edit-11 Text Editor Programmer's Manual, DEC-11-EEDA-D)

i. ODT-11R Debugging Program (BATCH-11/DOS-11 ODT-11R Debugging Program Programmers Manual, DEC-11-OODA-D)

j. Others (Other system programs which are operational; it is clear this part of the outline is open for expansion as the system is added to.)

3. Cookbooks

a. Job control language - BATCH

By this we intend a folding pamphlet containing basic job control statements to compile, link and execute a FORTRAN IV program in the BATCH mode. As actual operating experience is gained with the BATCH system, it seems likely that revision of the pamphlet will be necessary.

b. IMAGE 100 orientation

A brief applications oriented description of use of the

IMAGE 100 system functions in actual application with color photographs of how the screen looks, examples of what choice of channels or passes is appropriate for various users; this information would be of great value to the operators in explaining to a new user what to expect, and would also serve to illustrate to potential users some of the actual applications.

4. FORTRAN conversion problems

   The conversion of a program from one computer installation to another is never trivial, but, when the conversion involves change to a 16 bit machine from a machine with at least 32 bit words, the problems may seem almost insurmountable. This section of the outline should initially contain hints on probable problems in converting an operational FORTRAN IV program to the PDP 11/45 computer. In order to make this information as useful as possible, it should be made easy to revise and add to as experience is gained with actual conversion problems.

5. Concise summary of all error messages issued by system programs

   A tabular summary of error messages enabling a user to discover which component of the system issued the message and its meaning should be available to both BATCH and Interactive users.

6. Other system software

7. Updating standards

D. Library Documentation

Since all programs must be tested for correctness and occasionally modified, adequate documentation is a must so that future users may know exactly what a particular program is supposed to accomplish and how.

1. Program documentation standards

    a. Batch and conversational

    b. Interactive special functions

2. Image Analysis Library

    a. Pre-analysis data processing library

    b. General mathematical library

    c. General statistical library

    d. Pattern recognition library

3. Interactive special functions

    These are interactive programs run from the IMAGE 100 console.

4. Updating standards

E. Interface

In a PDP 11/45 computer system, hardware units generally communicate with the Central Processing Unit and each other through the Unibus high speed data bus by direct interfacing (wires) or by data communication interfacing (usually a telephone or other low-speed line with a moden unit on each end). Each unit of hardware communicates with an interactive user or with the computer operator through a control panel interface. Especially in an interactive environment, programmers (and sometimes users) need to be aware of technical details of how commands are decoded, how data is routed and how correct timing is maintained. Subroutines and functions exist which would allow a FORTRAN IV programmer to write interactive programs making efficient use of interactive hardware capabilities if the programmer understood how to use the interfacing software.

1. Interface documentation standards

    Each type of interface should be provided with a documentation

standard sufficient to allow the interface to be maintained and used.

2. Interface documentation by hardware unit

3. Updating standards

COMPLETED SECTIONS OF PROCEDURES MANUAL

A.3	Hardware Documentation Updating Standards
B.4.a (3)	System Software Maintenance--Filing and Updating Standards
B.4.b (2)	Batch and Conversational Library Maintenance--Software Problem Report Form
B.4.b (3)	Batch and Conversational Library Maintenance--Filing and Updating Standards
B.4.c (2)	Interactive Software Maintenance--Problem Report Form
B.4.c (3)	Interactive Software Maintenance--Filing and Updating Standards
C.3.a	Job Control Language Cookbook
C.4	FORTRAN Conversion Problems
C.7	System Software Documentation Updating Standards
D.1	Library Documentation Standards
D.4	Library Documentation Updating Standards
E.1	Interface Documentation Standards
E.3	Interface Updating Standards

A.3 Hardware Documentation Updating Standards

Each change in the system hardware configuration shall be documented as follows:

Change	Action
Addition of a hardware unit	Appropriate information shall be added to the Procedures Manual. (For reference, the distribution of this information throughout is listed below.) Section A.1 (Hardware configuration) shall contain references to sections of the Procedures Manual containing information about the added unit immediately following the general description of the unit.
Removal of a hardware unit	No longer applicable information shall be indicated by means of vertical line along the outer margin with a dated comment describing the change as "removed (date)". When several consecutive pages which would require this treatment can be fastened together securely only the first page need have the change indicated.
Modification or rearrangement	Changes induced shall be indicated by means of a vertical line along the outer margin with a dated comment describing the change as "changed (date) (page reference)" with a reference to currently applicable information. When possible, additions shall be physically near (in the Procedures Manual) the items they modify.

Reference information on distribution of hardware documentation:

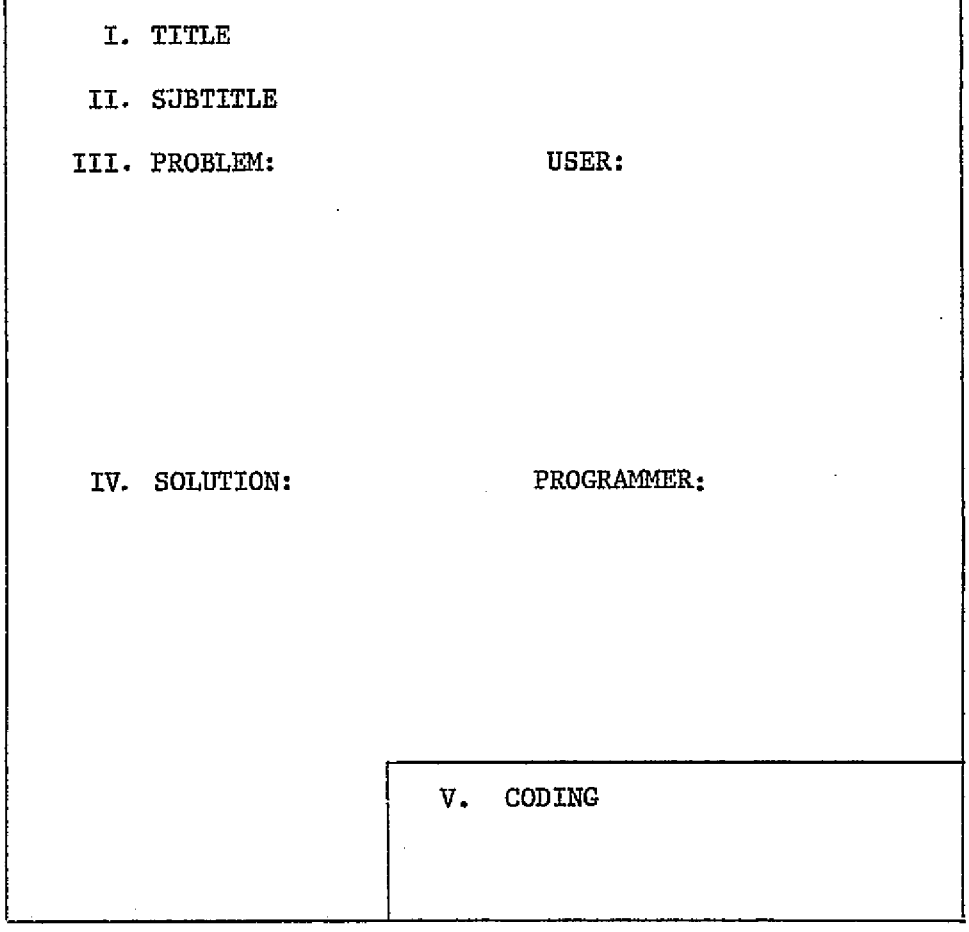
Item	Section
Accessories	A.2
Block diagrams	A.2
Code charts	E.2
Control operation	A.2
Control panel interface	E.2
Data flow	E.2
Data lines	E.2
Detailed physical description	A.2
Diagnostic software	E.2
Electrical diagrams	A.2
Floor plan	A.1
General description	A.1
Hardware dependent software	E.2
Initial checkout procedures	B.2.a
Initialization (interface)	E.2
Installation	B.2.a
Interface design	E.2
Interfacing procedures	E.2
Logic flow	A.2
Normal operation	A.2
Operating environment (physical)	A.2
Power requirements	A.2
Preventive maintenance	B.3.c
Principles of operation	A.2
Timing	E.2
Tools and test equipment required	B.3.c
Unpacking and inspection	B.3.a
Warranty information	B.3.a

B.4.a (3) System Software Maintenance--Filing and Updating Standards

Filing and updating standards for system software failure report forms shall be those described in DEC document Software Performance Summary (DEC-11-XSPSB-A-D), Copyright 1974, Digital Equipment Corporation, §2.

B.4.b (2) Batch and Conversational Library Maintenance--Software Problem Report Form

The maintenance of the Image Analysis Library requires the design and use of a new program problem report form, patterned after the system used by DEC (appearing in the Procedures Manual in B.4.a (2)). Each problem report takes the following overall form; each part will be explained in detail.



DATE: The date of the current version of the problem report.

I. TITLE

The title of the problem report refers to the component of the Image Analysis Library involved (for example, the Pattern Recognition Library)

II. SUBTITLE

This brief statement (which should fit on one line), gives the user a hint about the content of the problem report. The title and subtitle are to be used in a table of contents.

III. PROBLEM USER:

A paragraph is used to describe the problem in general terms, perhaps with an example, warnings, etc. The name and organization of the user reporting the problem appear here.

IV. SOLUTION: PROGRAMMER:

If there is a way to avoid the problem it is stated here.

V. CODING

This block is used for filing purposes. Below is a close-up view of the coding block

PROGRAM NAME	PROGRAM NUMBER	SEQUENCE #
ADDITIONAL INFORMATION (SUBROUTINES, FUNCTION)		PAGE OF
NEW ☐ REPLACEMENT # ☐		ORIGINAL DATE

Problem reports are filed by program (subroutine, function) name. Each program in the Image Analysis Library is assigned a number when accepted. The sequence numbers are assigned by program problem; as each new problem report for that program is filed it is assigned the next highest sequence number. Any additional information which may help a user is recorded. If the problem report is new (for this problem) an 'x' is placed in the NEW block; if a replacement, the revision number is placed in the REPLACEMENT # box. The original date is the date of the first report on this problem.

B.4.b (3) Batch and Conversational Library Maintenance--Filing and Updating Standards

Program Problem Reports shall be filed by program name and indexed by function as an element in the Image Analysis Library. When a problem is fixed or the program withdrawn, or information is added, the problem report shall be removed or replaced by a revision.

B.4.c (2) Interactive Software Maintenance--Problem Report Form

Interactive use of the system is by users who may not be programmers. To account for this, a slight redesign of the form in B.4.b (2) has been made:

DATE

I. MENU

II. OPTION/FUNCTION

III. SUBTITLE

IV. PROBLEM USER:

V. SOLUTION PROGRAMMER:

VI. CODING

DATE: Date of the current version of the problem report.

I. MENU

The menu refers to a user-selected set of options grouped together by the interactive system.

II. OPTION/FUNCTION

This describes which option was selected of the list under the menu of (I) above.

III. SUBTITLE

This is a brief (one line) description of the problem.

IV. PROBLEM: USER:

This is a one paragraph description of the problem with an example of a failure followed by the name and organization; action of the user reporting the problem.

V. SOLUTION: PROGRAMMER:

If there is a way to avoid the problem it is stated here, followed by the name and organization of the programmer who devised the solution.

VI. CODING

This block is used for filing purposes. Below is a close-up view of the coding block.

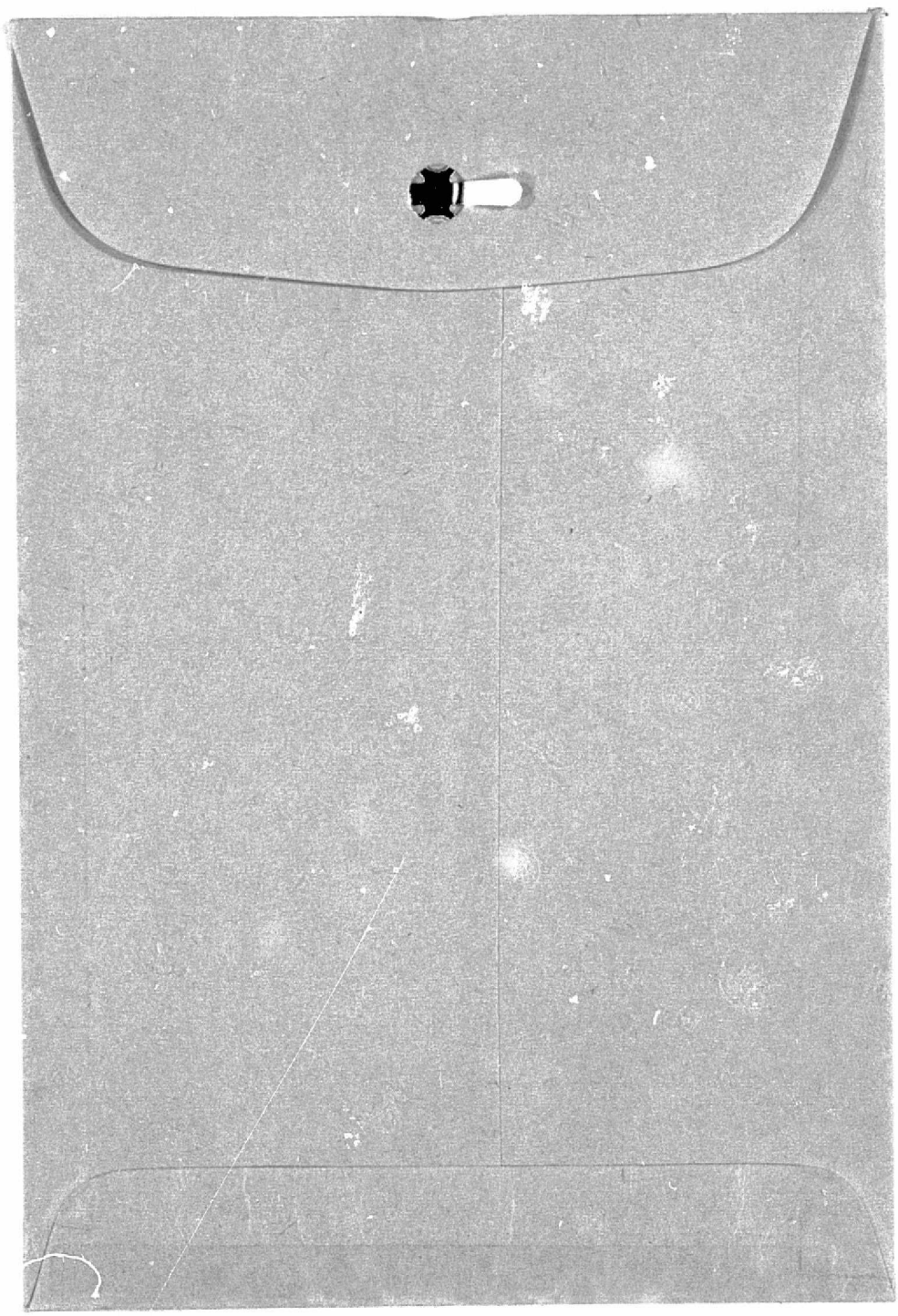
OPTION	SEQUENCE #
ADDITIONAL INFORMATION	PAGE OF
NEW ☐ REPLACEMENT # ☐	ORIGINAL DATE

Problem reports are filed by option name. Sequence numbers are assigned by option; as a new problem report for an option is reported, the next highest sequence number is assigned. If the problem report is new, an 'x' is placed in the NEW block; otherwise the revision number is placed in the REPLACEMENT # box.

B.4.c (3) Interactive Software Maintenance--Filing and Updating Standard

Problem reports shall be filed by option name and indexed by menu and function as an Interactive special function. When a problem is fixed or more information is added, the problem report shall be removed or replaced by a revision.

C.3.a Job Control Language Cookbook



C.4 FORTRAN Conversion Problems

The principal difficulties which arise when conversion of a FORTRAN IV program from a different implementation to PDP 11/45 is attempted stem from word length differences, core size differences, JCL differences and actual compiler bugs. The purpose of this section of the Procedures Manual is to allow users to share experience gained in attempting conversion so that an overall saving in effort (and frustration) can be realized. Much of the following information is contained in the FORTRAN Manual and the Software Performance Summary.

INTEGER Size:

Since the word length of the PDP 11/45 is 16 bits, the maximum signed integer is 2**15 - 1 = 32,767. "Double Precision" integers are not supported.

BYTE (LOGICAL * 1) Variables and Arrays:

BYTE (or LOGICAL * 1) variables and arrays cannot be initialized in DATA statements. The complier allows simple BYTE variables to be used in arithmetic statements but does not allow them in arithmetic IF statements. Comparison with Hollerith strings leads to unexpected results because Hollerith strings are treated as type INTEGER. A BYTE array element used as a subroutine argument sometimes causes an execution time addressing error.

ENCODE/DECODE Problems:

Core-to-core transfer under FORMAT control require care in that the area of core must be contiguous. Thus if INTEGER arrays are being processed, the program will have

to have been compiled with the /ON switch.

F FORMAT Problem:

Double precision variables are truncated when output under F FORMAT control.

EQUIVALENCE Problem:

Alignment to even bytes is necessary in EQUIVALENCE statements.

DEFINE FILE Problem:

Multiple DEFINE FILE statements are not compiled correctly, nor is a diagnostic message issued.

UNARY MINUS:

Unary minus is given precedence over exponentiation. Thus -2**2 is treated as (-2)**2 instead of the standard -(2**2).

ENDFILE Problems:

ENDFILE cannot be the statement to be conditionally executed in a logical IF. ENDFILE cannot be the first executable statement in a subroutine.

Logical Unit Numbers as Subroutine Arguments:

The compiler does not recognize integer variables passed as subroutine arguments as valid I/O logical unit numbers. A dummy assignment to a local variable is necessary to fix the problem.

C.7 System Software Documentation Updating Standards

As system software is updated or revised, changes shall be indicated in the Procedures Manual as follows:

Change	Action
Addition of a component of system software	Documentation and user information shall be included at the proper place.
Removal of a component of system software	No longer applicable documentation shall be indicated by a vertical line along the outer margin with a dated comment describing the change as "removed (date)". When several consecutive pages which would require this treatment can be fastened together securely only the first page need have the change indicated.
Modification	Changes induced shall be indicated by a vertical line along the outer margin with appropriate dated comment and reference to corrected or updated documentation.

D.1 Library Documentation Standards

The sharing of computer programs by a number of users requires that their documentation be managed so as to insure uniformity without imposing an undue clerical burden. While documentation must be performed at the same time the program is being developed, a requirement that a formal standard be satisfied at all levels would be costly. We recognize four levels of documentation:

LEVEL 1 Minimal level

Level 1 documentation standards apply to single-use programs of minimal complexity. The documentation required shall be the completion of the first page of the computer program documentation form, a liberally commented listing and test case.

LEVEL 2 Internal level

Level 2 documentation standards apply to larger special purpose programs which appear to have no sharing potential. The documentation required shall be the completion of pages 1 - 4 of the computer program documentation form, a liberally commented listing and a test case.

LEVEL 3 Working document level

Level 3 documentation standards apply to programs which are intended to be shared, either as parts of the Image Analysis Library or as special functions for Interactive use. In addition to Level 2 documentation, all basic elements of good documentation must be prepared and kept in the Library.

LEVEL 4 Interactive use level

Level 4 documentation standards apply to programs which are intended to be used in an interactive mode. In addition to Level 3 documentation, page 5 of the computer program documentation form (which describes operation of the program in an interactive mode to a user who may not understand the program) must be completed.

Basic elements of good documentation:

Title page

Table of contents

Abstract - brief summary of function or purpose

Problem task description - technical description of problem to be solved or task to be accomplished

Method of solution - mathematical techniques used, logical sequencing within the program and data files created by the program

Program description:

- Operating Environment - hardware and software requirements
- Program specifications - a detailed description of the programming techniques used in writing the program; e.g. calling sequence, overlay structure, test plan, COMMON usage
- Subprograms (other than library) - with appropriate level of documentation
- Non ANSI FORTRAN IV library subprograms--names and brief description
- Source code listing
- Flow charts--general and detailed

Operating instructions - description of procedure required to set up and run the program, including:

- Deck setup - showing placement of control cards, source or object decks and data
- Description of input - file, record and data element descriptions and formats including the origin of each data element
- Description of output - file, record and data element description and formats of each data element including scratch or intermediate files
- Restrictions or limitations - hardware or software restrictions, data ranges and capacities, program behavior when restrictions are violated
- Accuracy characteristics - including dependence on machine word length or floating point arithmetic
- Diagnostics emitted - including probable cause of program-generated messages
- Test Cases
- Special instructions - interactive mode
- Symbols - a complete tabular list of all symbols and array names used in the program, defined with reference to the mathematical or technical writing notations and terms used in the problem description, with units given where applicable

Record of changes - arranged in columnar form providing spaces for the change number, date and individual making the change,

with a brief description of the reason for the change;

actual changes should be made in the document itself

References

Computer Program Documentation Form

Date: / /

Program No. _____

Parent Program No. _____

Keywords and phrases: _____

Title: _____

Author: _____

Author location: _____

_____

Contact: _____

Abstract:

Application: _____

Computer type: _____ System or monitor: _____

Source language(s): _____ (%) _____ (%)

Memory required, other than monitor: _____

List program numbers of any required subprograms that are documented separately

_____ _____ _____ _____ _____ _____

_____ _____ _____ _____ _____ _____

I/O Configuration

File name, logical or physical unit no.	Device Type	Required	Optional	Input	Output	Scratch	Description/Remarks

Known restrictions:

File description:

Deck set-up:

Operating instructions:

Terminating conditions:

Timing:

References:

Revision or modification history:

Rev. No.	Date	Programmer, Loc., Ext.	Reason

Implementation level and material available

[ ] Reference only Form _____ Count _____

[ ] Source listing Form _____ Count _____

[ ] Source deck Form _____ Count _____

[ ] System device Device code, file name, ext. _____

[ ] Object module

[ ] Load module

[ ] Additional documentation _____

Estimated time and cost for development:

Manmonths_____ Machine hours_____ Total cost $_____

Interactive user instructions

Menu

Option name

Load and start procedure

Expected wait time

User instructions

Error messages

Error recovery

Effect on system parameters

UIC

Protection code

Files created

COMMON variables

Image 100 hardware affected

Other

D.4 Library Documentation Updating Standards

Each program in the Image Analysis Library and each Interactive special function shall be documented with a revision or modification history in which a record is kept of the revision number, date, programmer and reason. Should a program which is on a public disk be withdrawn, notice shall be posted on the software failure bulletin board. Every possible step shall be taken to insure upward compatibility of program revisions or modifications.

E.1 Interface Documentation Standards

a. Hardware - CPU interface

The connection of hardware units to the central processing unit shall be described in detail including information on initialization, data flow, data lines, timing, interface design and interfacing procedures.

b. Hardware - control panel interface

The connection of control panel switches, keys and controls to the data flow and interface bit status shall be described in detail.

c. Hardware - software interface

In the documentation of each Interactive software unit, the action of hardware controls on software variables shall be described. Utility software which exists for the purpose of enabling users to poll the status of hardware units or hardware controls shall be documented fully here.

E.3 Interface Updating Standards

The updating standard for change in the hardware configuration is set in section A.3.

Changes in the utility software shall be documented following the standard for system software maintenance under the component name "UTILITY".

APPENDIX B

IMAGE ANALYSIS LIBRARY OUTLINE

COMPUTER PROGRAM IDENTIFICATION FORMS

IMPLEMENTATION PRIORITY SUMMARY

IMAGE ANALYSIS LIBRARY OUTLINE

A. PRE-ANALYSIS DATA PROCESSING LIBRARY

1. PREPROCESSING PACKAGE

   a. RADIOMETRIC CORRECTION

   b. SUN ANGLE CORRECTION

   c. HAZE CORRECTION

   d. MEAN LEVEL ADJUSTMENT

   e. GENERAL SCANNER UNIT CORRECTION (IMAGE 100)

   f. ERTS DISTORTION CORRECTION

   g. I/O OF VARIOUS FORMATS

2. REGISTRATION PACKAGE

   a. SINGLE PASS TO GEOGRAPHICAL MAP OR AERIAL PHOTO

   b. SEVERAL PASSES TO DESIGNATED PASS

3. TRAINING FIELD SELECTION PACKAGE

   a. IRREGULARLY SHAPED FIELDS

   b. HISTOGRAMS FROM LINEAR COMBINATIONS OF n CHANNELS

   c. GREY SCALE MAP PROGRAM

   d. CONTOUR PROGRAM

4. SIMULATED DATA GENERATOR PACKAGE

   a. RANDOM NUMBER GENERATOR--VARIOUS DISTRIBUTIONS

   b. SIMULATED ERTS DATA

IMAGE ANALYSIS LIBRARY OUTLINE (CONT'D)

B. GENERAL MATHEMATICAL LIBRARY

1. LINEAR ALGEBRA PACKAGE
   a. LU DECOMPOSITION
   b. MATRIX INVERSE
   c. CHOLESKY METHOD---SYMMETRIC POSITIVE DEFINITE
   d. GENERALIZED INVERSE
   e. EIGENVALUE PROBLEM: $Ax = \lambda x$, A SYMMETRIC
   f. GENERALIZED EIGENVALUE PROBLEM: $Ax = \lambda Bx$, A, B SYMMETRIC
   g. HOUSEHOLDER TRANSFORMATION
   h. SINGULAR VALUED DECOMPOSITION
   i. POLAR DECOMPOSITION
   j. MATRIX MANIPULATION ROUTINES (GENERAL)
2. OPTIMIZATION PACKAGE
   a. LINEAR PROGRAMMING
   b. QUADRATIC PROGRAMMING
   c. GRADIENT-STEEPEST DESCENT
   d. FLETCHER POWELL DEFLECTED GRADIENT
   e. NEWTON'S METHOD AND VARIATIONS
   f. CONSTRAINED LEAST SQUARES
3. APPROXIMATION PACKAGE
   a. SPLINE APPROXIMATION--SINGLE VARIABLE
   b. SPLINE APPROXIMATION--TWO VARIABLES
4. TRANSFORM PACKAGE
   a. FAST FOURIER TRANSFORM
   b. HADAMARD TRANSFORM
   c. WALSH TRANSFORM

C. GENERAL STATISTICAL LIBRARY

1. STATISTICAL SUMMARY PACKAGE

   a. MEAN VECTOR COMPUTATION

   b. VARIANCE-COVARIANCE MATRIX COMPUTATION

   c. MODE, MEDIANS, RANGE, ETC.

2. DENSITIES & DISTRIBUTIONS PACKAGE

   a. MULTIVARIATE NORMAL

   b. UNIVARIATE NORMAL

   c. ERROR FUNCTION AND INVERSE ERROR FUNCTION

   d. UNIVARIATE DENSITIES---MISCELLANEOUS

3. REGRESSION PACKAGE

   a. MULTIPLE LINEAR REGRESSION

   b. NONLINEAR REGRESSION

4. STATISTICAL TESTS PACKAGE

   a. HYPOTHESIS TESTS

   b. GOODNESS OF FIT

   c. ANALYSIS OF VARIANCE

IMAGE ANALYSIS LIBRARY OUTLINE (CONT'D)

D. PATTERN RECOGNITION LIBRARY

1. CLUSTERING PACKAGE
   a. ISOCLS
   b. SEMI-SUPERVISED CLUSTERING (G.E.)
2. CLASSIFICATION PACKAGE
   a. BAYES OPTIMAL--m GAUSSIAN CLASSES
   b. BAYES OPTIMAL--CONVEX COMBINATIONS OF GAUSSIAN
   c. TABLE LOOKUP
   d. MAXIMUM LIKELIHOOD RESOLUTION (G.E.)
3. FEATURE SELECTION PACKAGE
   a. DIVERGENCE CRITERION
   b. BHATTACHARYYA DISTANCE
   c. PROBABILITY OF MISCLASSIFICATION
   d. LINEAR DISCRIMINANT FUNCTIONS
   e. TRANSFORMED DIVERGENCE
4. ESTIMATION OF PROPORTION PACKAGE
   a. MAXIMUM LIKELIHOOD
   b. METHOD OF MOMENTS
   c. ESTIMATED CONFUSION MATRIX
   d. CLASSIFICATION
   e. BAYES WEIGHTS--CONFUSION MATRIX
5. SPATIAL PATTERN RECOGNITION PACKAGE
   a. FIELD BOUNDARY DETECTION
   b. SPATIAL FEATURE DEFINITION
   c. CLASSIFICATION USING SPATIAL FEATURES
6. SIGNATURE EXTENSION PACKAGE
   a. MAXIMUM LIKELIHOOD FOR MEAN, COVARIANCE, PROPORTIONS USING UNLABELED SAMPLES AND CONTRACTABILITY
   b. Ax + b, A DIAGONAL, CORRECTION TRANSFORMATION (UNLABELED SAMPLES)

COMPUTER PROGRAM IDENTIFICATION FORMS

The computer subroutines and programs which were identified appear in the following pages. They have been arranged into the packages defined in the outline of Image Analysis Library. In some cases no computer programs were identified which provide a required functional capability. We have tried to indicate through notes on the header page for each package where such programs exist for purposes of future identification and acquisition.

A. PRE-ANALYSIS DATA PROCESSING LIBRARY

1. PREPROCESSING PACKAGE

Computer programs are available to meet some of the functional requirements of this package and can be supplied by either LEC or ERIM.

I. NAME: GENERAL RADIOMETRIC CORRECTION

II. SOURCE (include coder/person with knowledge of program usage):
General Electric/Jim Brienly

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: IMAGE 100/PDP-11

IV. PURPOSE: See next page

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See next page

Description: See next page

VI. SPECIAL FEATURES: None

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: $7,712
Is X Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose X Special purpose X Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE X Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

1.1.2 GENERAL RADIOMETRIC CORRECTION

Adjustment of the radiometric amplitudes of raw ERTS-1 MSS data may be effected using this program. Three modes of operation are available for handling a variety of data adjustment techniques:

a. General Mode

This mode assumes that the data requires correction as a function of x-y position and channel. The form of the correction applied to each pixel is,

$$S'(x,y) = S(x,y)*f(ch)*s(ch)+t(x,y)*g(ch)$$

where

S is the radiometric amplitude of each pixel; x,y are ERTS MSS frame coordinates; ch is the ERTS MSS channel; f, g, s, t are user-supplied functions.

b. Channel Correction Mode

This mode permits the user to apply a stored lookup table correction to each of the four channels. This is to correct (or linearize) non-linear scanner sensor outputs. The lookup tables are generated under user control for each channel from the following functions:

(1) $S' = aS^2 + bS + c$ (square law function)

(2) $S' = a \ln (S+1) + b$ (log function)

(3) $S' = ae^S + b$ (exponential function)

(4) Three-segment piecewise linear curve with break-points at a and b corresponding to the 10 percent and 90 percent amplitude points.

c. Sensor Correction Mode

This mode is applied to correct for calibration differences between ERTS-1 MSS sensors. Each image line is referenced back to its sensor and a stored lookup table correction is applied. The lookup tables may be loaded at the user's request; this is accomplished by scanning the image and loading each table with the corrections that provides uniform values for the mean of each sensor within a band. In this fashion, so-called "banding" corrections may be made.

A. PRE-ANALYSIS DATA PROCESSING LIBRARY

2. REGISTRATION PACKAGE

COMPUTER PROGRAM IDENTIFICATION FORM
THIS FORM PREPARED BY LEC

I. NAME: CORLAT

II. SOURCE (include coder/person with knowledge of program usage):
S. YAO/LEC

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: UNIVAC 1108

IV. PURPOSE: Does two-dimension image correlation using the fast Fourier transform technique

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: By inputting a reference and an overlay image and the correlation patch-size, the output correlation function and correlations coefficients are obtained.

VI. SPECIAL FEATURES: One can either correlate on designated Line-pixel points or specify a set of correlation grid points.

VII. SUBROUTINES REQUIRED: HARM (2D-FFT from IBM Scientific Subroutine package)

VIII. DOCUMENTATION: ___Available _x_Not Available ___Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____

Is _x_ Is not ___compatible with Image 100 configuration in present form

___Non-PDP 11/45 FORTRAN

___Some machine language conversion necessary

___In language other than FORTRAN. Specify _____

___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

_x_ General purpose ___Special purpose ___Program package

_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE

___Training ___Classification ___Estimation of Proportion

___Feature Selection ___Signature Extension

___Temporal Sampling ___Systems Development ___Technique Development

___Crop Assessment ___Yield Estimation

_x_ Other (specify) Pre-processing--Registration

I. NAME: REGSTR

II. SOURCE (include coder/person with knowledge of program usage):
S. YAO

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: UNIVAC 1108

IV. PURPOSE: Does linear (1st order) geometrical corrections on 2-D images based on six input parameters--two scaling, two translation and two rotation.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: REGSTR maps the overlay image onto the reference image, with output image similar to the reference image in geometrical properties. A buffer is created to store the overlay image for output one line at a time.

VI. SPECIAL FEATURES: REGSTR does "REGISTRATION" based on results obtained from CORLAT. It contains the tape-merge provision, that is, one output image can be obtained from merging two adjacent ERTS strips.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available _x_Not Available ___Will be Available

IX. _x_Software available off-the-shelf. Approximate Cost: _____
Is _x_Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_x_General purpose ___Special purpose ___Program package
_x_PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE _x_Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
_x_Other (specify) pre-processing--REGISTRATION

A. PRE-ANALYSIS DATA PROCESSING LIBRARY

3. TRAINING FIELD SELECTION PACKAGE

A program which provides the capability of selecting irregularly shaped training fields has been developed on the Image 100 System by Ted Kell, LEC.

A display package which makes use of linear combinations of channels is being developed by Dr. Jack Bryant, Texas A&M University.

COMPUTER PROGRAM IDENTIFICATION FORM
THIS FORM PREPARED BY LEC

I. NAME: IRREGULARLY SHAPED TRAINING FIELDS

II. SOURCE (include coder/person with knowledge of program usage):
Ted Kell

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: IMAGE 100

IV. PURPOSE: Select training fields with odd shapes and/or sizes.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Program under development by Ted Kell.

Description: This program will permit the selection of odd shaped training fields (the current system permits only rectangular fields).

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___ Available X Not Available ___ Will be Available

IX. ___ Software available off-the-shelf. Approximate Cost: _____
Is X Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE X Non-LACIE
x Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development X Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

THIS FORM PROVIDED BY LEC

I. NAME: Line find

II. SOURCE (include coder/person with knowledge of program usage):
Ted Kell

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: PDP11/45

IV. PURPOSE: To detect lines in a scene and display them on the CRT.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available ___Not Available ___Will be Available

IX. ___Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose x Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: Grey Scale Map Package For High Speed Printer

II. SOURCE (include coder/person with knowledge of program usage):
Jack Bryant, Dept. Math. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV, PLI COMPUTER: IBM 360/65

IV. PURPOSE: To produce single channel grey scale maps on a high speed printer.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Jack Bryant, Program documentation OCM, HISTOG, PRINTUM, Report #35, Contract NAS-9-12777, Department of Mathematics, University of Houston, August, 1974.
Description: Computes histograms from single channel of ERTS data (single pass or registered) and produces a grey scale map on the high speed printer (8 levels of grey).

VI. SPECIAL FEATURES: Three separate main programs - not a subroutine package.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -0-
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
x In language other than FORTRAN. Specify IBM 360 Assembly Language
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose X Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
x Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: PROGRAM PRINTUM

II. SOURCE (include coder/person with knowledge of program usage):
Jack Bryant, Dept. Math. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: Calculate cumulative distributions of the histograms.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Jack Bryant, "Program Documentation OCM, HISTOG, PRINTUM," Univ. of Houston Report 35, August 1974, NAS9-12777.

Description: Calculate cumulative distributions(estimate maximum & minimum significant data values to be input to OCM)

VI. SPECIAL FEATURES:,

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -0-
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
x Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: PROGRAM HISTOG

II. SOURCE (include coder/person with knowledge of program usage):
Jack Bryant, Dept. Math. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: Outputs complete histograms of all channels.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Jack Bryant, "Program Documentation OCM, HISTOG, PRINTUM", Univ. of Houston Report 35, Aug. 1974, NAS9-12777.

Description: Accumulates, prints, punches, complete histograms of all channels used as input to OCM.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
x Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: PROGRAM OCM

II. SOURCE (include coder/person with knowledge of program usage):
Jack Bryant, Dept of Math., TX A&M Univ 77843

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: One channel map.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Jack Bryant, "Program Documentation OCM, HISTOG, PRINTUM", Univ. of Houston Report 35, Aug. 1974, NAS9-12777.

Description: Reproduces digital picture on high speed printer by printing an appropriate selection of characters.

VI. SPECIAL FEATURES: 8 shades of gray can be reproduced.

Requires high speed printer

VII. SUBROUTINES REQUIRED: HPO5, COLS, TODEC

VIII. DOCUMENTATION: _x_ Available ___ Not Available ___ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not _x_ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

_x_ Some machine language conversion necessary

_x_ In language other than FORTRAN. Specify IBM 360 Assembly Language

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose _x_ Special purpose ___ Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE

_x_ Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development _x_ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: KONTUR Program Package

II. SOURCE (include coder/person with knowledge of program usage):
Charles Eleuterius, Dept. of Oceanography, TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To plot, on either a CALCOMP or Gerber plotter, a contour map built from a two-dimensional array of data values. The array size may be quite large.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: KONTUR, a modification to program CONMAP by David C. Haley of Lockheed Electronics Company written under NASA contract #NSA 0-5384. For reference to modification--"source" above.
Description: The surface is approximated by elementary rectangles with grid points at the corners. All isolines that traverse the rectangle will be drawn while those four points are being considered.

VI. SPECIAL FEATURES: A code deck is read as the first part of the input data; it contains a decision table to determine cases. The code deck must be obtained with the program.

VII. SUBROUTINES REQUIRED: CONMAP, READIN, TAMU

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose x Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
x Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: MAIN

II. SOURCE (include coder/person with knowledge of program usage):
Charles Eleuterius

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Inputs code deck and control parameters, calls CONMAP.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See KONTUR reference.

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: CONMAP, LINE4

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not _x_ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose _x_ Special purpose ___ Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE X Non-LACIE
_x_ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development _x_ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE CONMAP

II. SOURCE (include coder/person with knowledge of program usage):
Charles Eleuterius

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To permit contouring using very large data arrays. The output contour maps will be drawn on the CALCOMP or Gerber plotter.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See KONTUR reference

Description: Four data points are considered at a time, connected to form two triangles. The intersection line of these triangular planes with each of the contour planes is plotted.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: READIN, PLOT, FACTOR, SYMBOL, TAMU

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-

Is ___ Is not x compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose x Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

x Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development x Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE READIN

II. SOURCE (include coder/person with knowledge of program usage):
Charles Eleuterius

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To input grid array data

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See KONTUR reference

Description:

VI. SPECIAL FEATURES: User written so that data may be entered in form to conform to and take advantage of plotter characteristics of travel direction and resolution.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
x Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE TAMU

II. SOURCE (include coder/person with knowledge of program usage):
Charles Eleuterius

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To consider each successive rectangle and determine the type of isoline case.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See KONTUR reference.

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: DRAW

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
x Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE DRAW

II. SOURCE (include coder/person with knowledge of program usage):
Charles Eleuterius

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To draw actual contours, labeling the isolines, for each rectangle.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See KONTUR reference.

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: PLOT

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
x Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

A. PRE-ANALYSIS DATA PROCESSING LIBRARY

4. SIMULATED DATA GENERATOR PACKAGE

B. GENERAL MATHEMATICAL LIBRARY

1. LINEAR ALGEBRA PACKAGE

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE MINVSP (A, N, E, K) (single precision)
SUBROUTINE MINVDP (A, N, E, K) (double precision)

II. SOURCE (include coder/person with knowledge of program usage):
L. F. Guseman, Jr., Math. Dept. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: To invert a nonsingular N×N matrix A

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: E. G. N. Clayton, Compact methods for inverting matrices and solving simultaneous equations by use of Gauss-Jordan elimination, M. S. Thesis, Dept. Math., TAMU, May,1962.
Description:

Uses Gaussian elimination with pivoting.

VI. SPECIAL FEATURES:

The inverse is built into the array originally occupied by

A. The original matrix A is lost.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: LU-Decomposition Package

II. SOURCE (include coder/person with knowledge of program usage):
N.W. Naugle, Math. Dept. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: Package for solving linear systems AX=B where A is a square nonsingular matrix. Also provides capability to compute A^{-1}

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: George Forsythe and Cleve B. Moler, Computer Solution of Linear Algebraic Systems, Prentice-Hall, Inc. Englewood Cliffs, N.J., 1967, pp. 68-72.

Description:

Computes LU-decomposition of A

VI. SPECIAL FEATURES:

Original A is saved. Iterative improvement of solution or inverse is built in.

VII. SUBROUTINES REQUIRED:

DECOMP, SOLVE, IMPRUV, SING

VIII. DOCUMENTATION: _x_ Available ___ Not Available ___ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: ____-?-____
Is _x_ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_x_ General purpose _x_ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___ Training _x_ Classification _x_ Estimation of Proportion
_x_ Feature Selection _x_ Signature Extension
___ Temporal Sampling ___ Systems Development _x_ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE DECOMP (NN,A,UL)

II. SOURCE (include coder/person with knowledge of program usage):
N.W. Naugle, Math. Dept. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: To compute the LU-decomposition of a square nonsingular matrix A. Part of package to solve systems of equations and compute inverses.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See LU-Decomposition Package, p. 1 of 5

Description: Decomposes A into LU, where L is lower triangular with ones along the diagonal, and U is upper triangular. Uses scaling and Gaussian elimination with partial pivoting.

VI. SPECIAL FEATURES:

Original matrix A is saved.

VII. SUBROUTINES REQUIRED:

SING

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE SOLVE (NN,UL,B,X)

II. SOURCE (include coder/person with knowledge of program usage):
N.W. Naugle, Math. Dept. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: Given the LU-decomposition of A, and a constant vector B, the program solves LUX=B for X

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See p. 1

Description: Given a square matrix A with decomposition A=LU, and a constant vector B, the solution X of the equation LUX=B is obtained.

VI. SPECIAL FEATURES: Can obtain A^{-1} by solving $LUX_i=E_i$, where E_i is a unit vector with 1 in i^{th} slot, i= 1,2,...,NN

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE IMPRUV (NN,A,UL,B,X, DIGITS)

II. SOURCE (include coder/person with knowledge of program usage):
N.W. Naugle, Math, Dept. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: To improve the solution X of AX=B

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See p. 1

Description: Uses iterative procedure to improve solution X (of inverse) of AX=B. The procedure is machine dependent in that the tolerance and number of iterations specified depend on the word length of the machine.

VI. SPECIAL FEATURES:
Double precision accumulation of intermediate sums is required.

VII. SUBROUTINES REQUIRED:
SING

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available.

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE SING (INHY)

II. SOURCE (include coder/person with knowledge of program usage):
N.W. Naugle, Math. Dept. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: To print error messages for DECOMP and INPRUV

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See p. 1

Description: Error messages are printed if original matrix in DECOMP is singular or else no convergence is obtained in IMPRUV.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE GINV2M

II. SOURCE (include coder/person with knowledge of program usage):
F.M. Speed, Dept. Math. Mississippi State Univ.

III. PROGRAMMING LANGUAGE: FORTRAN IV, G COMPUTER: 360

IV. PURPOSE: To compute the generalized inverse of a matrix.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Adi Ben-Israel and Thomas N. E. Greville, Generalized Inverse--Theory and Applications, Wiley Interscience, 1974.

Description: Uses Gram-Schmidt Orthogonalization

VI. SPECIAL FEATURES: Generalized inverse is computed in location occupied by original matrix.

VII. SUBROUTINES REQUIRED: FUNCTION DOT

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: FUNCTION DOT (double precision)

II. SOURCE (include coder/person with knowledge of program usage):
F.M. Speed, Dept. Math. Mississippi State Univ.

III. PROGRAMMING LANGUAGE: FORTRAN IV , G COMPUTER: 360

IV. PURPOSE: Inner product of two columns of a matrix.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE CHLSKY (double precision)

II. SOURCE (include coder/person with knowledge of program usage):

Paul R. Hendrick/L. F. Guseman, Jr. Dept. Math. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To obtain the modified (sometimes called "alternate form") Cholesky decomposition of a real symmetric positive definite matrix A, and then its inverse.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Wilkinson, J. H. and Reinsch, C., Handbook for Automatic Computation, Vol. II, Linear Algebra, Springer-Verlag, New York, 1971, pp. 9-30.

Description: The routine is a translation and slight modification of the Algol routine "syminversion" of above reference. The matrix A is decomposed into LDL^T, with L unit lower tridiagonal and D positive diagonal.

VI. SPECIAL FEATURES:

The parameter DET input into Chlsky calls for the inverse and/or determinant to be computed if DET is non-negative or positive, respectively. DET returned as non-positive indicates A is not positive definite, either originally or through accumulation of roundoff error.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is x Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose ___ Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

___ Training x Classification ___ Estimation of Proportion

x Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development x Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: TSTMIS (Single precision)
TSTMID (Double precision)

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman,Jr.

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Program for testing matrix inversion routines for accuracy.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Randall E. Cline, A class of matrices to test inversion procedures, Comm. ACM 7(1964), 724-725.

Description: Given an n×n matrix $T=(t_{ij})$, where $t_{ij}=1$ if $i\neq j$

$t_{ii}=d$, where $d\neq 1$, $d\neq -(n-1)$, the inverse is given by $T^{-1}=(t^{-1}_{ij})$, where $t^{-1}_{ii}=\frac{1}{d-1}\left(\frac{n+d-2}{n+d-1}\right)$, $t^{-1}_{ij}=\frac{1}{d-1}\left(\frac{-1}{n+d-1}\right)$, $i\neq j$.

VI. SPECIAL FEATURES:
Eigenvalues are given by $\lambda_1 = (n + d - 1)$ and $\lambda_i = d-1$, $2\leq i\leq n$, and can be used to construct matrices with desired condition number. CALL Statement must be modified to call routine being tested.

VII. SUBROUTINES REQUIRED: Inversion routine being tested.

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE SEIGEN(A,W,AW,C,R,N,DIGIT,NMAX)

II. SOURCE (include coder/person with knowledge of program usage):
W. L. Morris, Math Dept., University of Houston, Houston, Texas 77004

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108/EXEC 8

IV. PURPOSE:
Compute eigenvectors and eigenvalues for a real symmetric matrix

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: W. L. Morris, Inclusion theorems for a section of a matrix, Numer. Math 8(1972), pp. 454-464.

Description:
Reduces calculations to that for eigenvalues of sequence of matrices of order 2

VI. SPECIAL FEATURES:

Requires approximate no. of equivalent decimal numbers in floating point representation for the given machine.

VII. SUBROUTINES REQUIRED:
SUPSUM RHA
ORDER RINPRD
MINDEX

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: -?-
Is X Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
X General purpose ___ Special purpose x Program package
X PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE X Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development X Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE MINDEX(R,JM,IM,N)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 1108

IV. PURPOSE: Indices of ascending elements of a vector are placed in another vector

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: JM vector will contain the indices of ascending elements of R

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available _X_ Not Available ___Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____

Is _X_ Is not ___ compatible with Image 100 configuration in present form

___Non-PDP 11/45 FORTRAN

___Some machine language conversion necessary

___In language other than FORTRAN. Specify _____

__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___General purpose _X_ Special purpose ___Program package

_X_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _X_ LACIE _X_ Non-LACIE

___Training _x_ Classification _x_ Estimation of Proportion

_x_ Feature Selection _x_ Signature Extension

___Temporal Sampling ___Systems Development _X_ Technique Development

___Crop Assessment ___Yield Estimation

___Other (specify) _____

I. NAME: FUNCTION RHA(A,B,C,U,N)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 1108

IV. PURPOSE: For a fixed column of A and B matrices, calculate inner product A = C * B

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: Uses RINPRD for inner product

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

RINPRD

VIII. DOCUMENTATION: ___Available _X_ Not Available ___Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____

Is _x_ Is not ___ compatible with Image 100 configuration in present form

___Non-PDP 11/45 FORTRAN

___Some machine language conversion necessary

___In language other than FORTRAN. Specify _____

__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___General purpose _x_ Special purpose ___Program package

_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_LACIE _x_ Non-LACIE

___Training _x_Classification _x_ Estimation of Proportion

_x_ Feature Selection _x_ Signature Extension

___Temporal Sampling ___Systems Development _x_Technique Development

___Crop Assessment ___Yield Estimation

___Other (specify) _____

I. NAME: FUNCTION RINPRD(A,B,N)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 1108

IV. PURPOSE: Real inner product of vector with another vector

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description:
A * B = RINPRD

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

SUPSUM

VIII. DOCUMENTATION: ___Available _X_ Not Available ___Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is _x_ Is not ___ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose _x_ Special purpose ___Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___Training _x_ Classification _x_ Estimation of Proportion
_x_ Feature Selection _x_ Signature Extension
___Temporal Sampling ___Systems Development _x_ Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: DOUBLE PRECISION FUNCTION SUPSUM(A,I,N)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN IV, G COMPUTER: 360/44

IV. PURPOSE: Vector elements summed

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description:

VI. SPECIAL FEATURES: Reduced round-off error

VII. SUBROUTINES REQUIRED:
ORDER

VIII. DOCUMENTATION: ___Available _X_ Not Available ___Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is _x_ Is not ___ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose _x_ Special purpose ___Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___Training _x_ Classification _x_ Estimation of Proportion
_x_ Feature Selection _x_ Signature Extension
___Temporal Sampling ___Systems Development _x_ Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE ORDER (A,I1,I2,N)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN IV, G COMPUTER: 360/44

IV. PURPOSE: Orders elements of a vector in increasing absolute value

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available _X_ Not Available ___Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is _X_ Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose _X_ Special purpose ___Program package
_X_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _X_ LACIE _X_ Non-LACIE
___Training _x_ Classification _x_ Estimation of Proportion
_x_ Feature Selection _x_ Signature Extension
___Temporal Sampling ___Systems Development _X_ Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE DSVD(A,MMAX,NMAX,M,N,P,WITHU,WITHV,S,U,V)

II. SOURCE (include coder/person with knowledge of program usage):
G. H. Golub, Computer Science Dept., Stanford Univ., Stanford, Ca. 94305

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 1108, 360/67, CDC6600
ALGOL 60

IV. PURPOSE:
Singular value decomposition of rectangular matrix

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: G. H. Golub and C. Reinsch, "Singular value decomposition and least squares solutions," Numer. Math 14(1970), pp. 403-421.

Description:
Decompose a given matrix A into matrices U,S,V such that $A = U * S * V^T$

VI. SPECIAL FEATURES: A may be partitioned such that the submatrix B area will have the submatrix $U^T * B$. U and/or V may be used in the calculations depending on the flag

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: -?-
Is X Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
X General purpose ___ Special purpose ___ Program package
X PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE X Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development X Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE MATMUL(A,X,B,I,J,K,NA,NX,NB)

II. SOURCE (include coder/person with knowledge of program usage):
David Lowell

III. PROGRAMMING LANGUAGE: FORTRAN IV, G COMPUTER: 360/44

IV. PURPOSE: Matrix multiplication

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description:

A * X = B

VI. SPECIAL FEATURES:

Reduces round-off error
Variable dimensioning

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available _X_ Not Available ___Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: -?-
Is _X_ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose _x_ Special purpose ___ Program package
_X_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _X_ LACIE _X_ Non-LACIE
___ Training _x_ Classification _x_ Estimation of Proportion
_x_ Feature Selection _x_ Signature Extension
___ Temporal Sampling ___ Systems Development _x_ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

C-7

I. NAME: SUBROUTINE EIGEN

II. SOURCE (include coder/person with knowledge of program usage):
Paul R. Hendrick/L. F. Guseman, Jr. Department of Math. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To find all eigenvalues and eigenvectors of a real general matrix.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Smith, B. T., et al., Matrix Eigensystem Routines--EISPACK Guide, Springer-Verlag, Lecture Notes in Computer Science, vol. 6, New York, 1973.

Description: This is merely a driver routine and calls in order the routines which balance the matrix, transform it to upper Hessenberg form and accumulate the elementary similarity transformations, compute the eigenvalues and eigenvectors of the balanced matrix, and then backtransform these to the eigenvectors of the original matrix.

VI. SPECIAL FEATURES:

If the parameter IERR is returned as nonzero, the eigenvalue with its value as index was not computed in 30 iterations. Eigenvalues indexed from IERR + 1 to N should be correct. Eigenvectors have not been computed in this case.

VII. SUBROUTINES REQUIRED:

BALANC, BALBAK, ELMHES, ELTRAN, HQR2, UNPK

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is x Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose ___ Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE BALANC

II. SOURCE (include coder/person with knowledge of program usage): Burton S. Garbow, Argonne National Laboratory, Applied Mathematics Division, 9700 S Cass Ave., Argonne, Illinois 60439.

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: This subroutine balances a real matrix and isolates eigenvalues whenever possible.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Smith, B.T., et al., Matrix Eigensystem Routines—EISPACK Guide, Springer-Verlag, Lecture Notes in Computer Science, New York, 1973.

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is x Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose ___ Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE BALBAK

II. SOURCE (include coder/person with knowledge of program usage): Burton S. Garbow, Argonne National Laboratory, Applied Mathematics Division, 9700 S. Cass Ave., Argonne, Illinois 60439

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: This subroutine forms the eigenvectors of a real general matrix by back transforming those of the corresponding balanced matrix determined by BALANC.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Smith, B.T., et al., Matrix Eigensystem Routines-EISPACK Guide, Springer-Verlag, Lecture Notes in Computer Science, vol. 6, New York, 1973.

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is x Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose ___ Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE ELMHES

II. SOURCE (include coder/person with knowledge of program usage): Burton S. Garbow, Argonne National Laboratory, Applied Mathematics Division, 9700 S. Cass Ave, Argonne, Illinois 60439

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Given a real general matrix, this subroutine reduces a submatrix to upper Hessenberg form by stabilized elementary similarity transformations.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Smith, B.T., et al., Matrix Eigensystem Routines-EISPACK Guide, Springer-Verlag, Lecture Notes in Computer Science, vol. 6, New York, 1973.

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is x Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose ___ Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE ELTRAN

II. SOURCE (include coder/person with knowledge of program usage): Burton S. Garbow, Argonne National Laboratory, Applied Mathematics Division, 9700 S. Cass Ave., Argonne, Illinois 60439

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: This subroutine accumulates the stabilized elementary similarity transformations used in the reduction of a real general matrix to upper Hessenberg form by ELMHES.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Smith, B.T., et al., Matrix Eigensystem Routines-EISPACK Guide, Springer-Verlag, Lecture Notes in Computer Science, New York, 1973.

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is x Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose ___ Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE HQR2

II. SOURCE (include coder/person with knowledge of program usage): Burton S. Garbow
Argonne National Laboratory, Applied Mathematics Division, 9700 S. Cass Ave.,
Argonne, Illinois 60439

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: This subroutine finds the eigenvalues and eigenvectors of a real upper Hessenberg matrix by the QR method.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Smith, B.T., et al., Matrix Eigensystem Routines-EISPACK Guide, Springer-Verlag, Lecture Notes in Computer Science, vol.6, New York, 1973.

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available __ Not Available __ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not __ compatible with Image 100 configuration in present form
__ Non-PDP 11/45 FORTRAN
__ Some machine language conversion necessary
__ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose __ Special purpose __ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: __ LACIE __ Non-LACIE
__ Training __ Classification __ Estimation of Proportion
__ Feature Selection __ Signature Extension
__ Temporal Sampling __ Systems Development __ Technique Development
__ Crop Assessment __ Yield Estimation
__ Other (specify) _____

I. NAME: SUBROUTINE UNPK

II. SOURCE (include coder/person with knowledge of program usage):
Paul R. Hendrick/L. F. Guseman, Jr. Dept. Math. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To break up the complex eigenvector matrix returned by eigenvector routines into its real and imaginary parts.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Smith, B. T., et al., Matrix Eigensystem Routines--EISPACK Guide, Springer-Verlag, Lecture Notes in Computer Science, vol. 6, New York, 1973, pp. 73-75.

Description: The eigenvectors are originally packed in one matrix, one real eigenvector per column corresponding to a real eigenvalue, or the real part and imaginary part in two adjacent columns corresponding to a conjugate pair of eigenvalues.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: _x_ Available ___ Not Available ___ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____

Is _x_ Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

_x_ General purpose ___ Special purpose ___ Program package

_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

B. GENERAL MATHEMATICAL LIBRARY

2. OPTIMIZATION PACKAGE

I. NAME: SUBROUTINE DFMFP

II. SOURCE (include coder/person with knowledge of program usage):
IBM 360/Scientific Subroutine Package-L. F. Guseman,Jr.

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: To find a local minimum of a function of several variables by the method of Fletcher and Powell.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: R. Fletcher and M.J.D. Powell, A rapidly convergent descent method for minimization, Comput. J. 6(1963), 163-168

Description:
Uses deflected-gradient method. Converges in a finite number of steps if the objective function is a quadratic form.

VI. SPECIAL FEATURES:
Requires a user-supplied subroutine which provides the values of the objective function and the gradient for each argument vector.

VII. SUBROUTINES REQUIRED:
FUNCT - User supplied subroutine as described above.

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: ___-?-___
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE FRKWLF

II. SOURCE (include coder/person with knowledge of program usage):
B. C. Peters, Jr. / L. F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To solve the quadratic programming problem: minimize $||Ax-y||$ subject to $\sum_{i=1}^{n} x_i = 1$, $x_i \geq 0$, $1 \leq i \leq n$

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: M. Frank and P. Wolfe, An Algorithm for Quadratic Programming, Naval Research Logistics Quarterly, Vol. 3, 1956.

Description: A modification of the Frank-Wolfe algorithm

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available x Not Available ___Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is x Is not ___ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___Special purpose ___Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___Training ___Classification x Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development x Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE QM431

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Minimization of a quadratic form subject to linear inequality and nonnegativity constraints on the variables (Quadratic programming problem)

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: A. Ravindran, Algorithm 431-A computer routine for quadratic and linear programming problems, Comm. ACM. 15 (1972), 818-820.

Description: Solves the quadratic program: minimize $z=c^{T}x+x^{T}Qx$ subject to $Ax\geq b$, $x\geq 0$ using Lemke's complimentary pivot algorithm Can also be used to solve linear programming problems.

VI. SPECIAL FEATURES: Original matrix Q is lost.

VII. SUBROUTINES REQUIRED: INITIA, NEWBAS, SORT, PIVOT

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. x Software available off-the-sheif. Approximate Cost: _____
Is x Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___Special purpose ___Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
__Training ___Classification x Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development x Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE INITIA

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To find the initial almost complementary solution by adding an artificial variable

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See QM431

Description:

VI. SPECIAL FEATURES: Part of QM431 package

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification x Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE NEWBAS

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To find the new basis column to enter in terms of the current basis in performing a simplex-type algorithm

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See QM431

Description:

VI. SPECIAL FEATURES: Part of QM431 package

VII. SUBROUTINES REQUIRED: PPRINT

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose x Special purpose ___Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___Training ___Classification x Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development x Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE PPRINT

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To place the current solution to complementary problem into the array ALPHA

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See QM431

Description:

VI. SPECIAL FEATURES: Part of QM431 Package

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification x Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE SORT

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To find the pivot row for next iteration by the use of (simplex-type) minimum ratio rule.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See QM431

Description:

VI. SPECIAL FEATURES: Part of QM431 package

VII. SUBROUTINES REQUIRED: PPRINT

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is x Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose x Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

___ Training ___ Classification x Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development x Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE PIVOT

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To perform the pivot operation by updating the inverse of the basis and Q vector.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See QM431

Description:

VI. SPECIAL FEATURES: Part of QM431 package

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose x Special purpose ___Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___Training ___Classification x Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development x Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: NDIMEN

II. SOURCE (include coder/person with knowledge of program usage):
Henry Decell, University of Houston, Math Dept.

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: UNIVAC 1108

IV. PURPOSE: To determine the simultaneous solution of an overdetermined system of nonlinear equations.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: An algorithm for solving overdetermined system of non linear equations, John Engvall MSC-IN-67-ED-49 (January, 1967).

Description:
Problem is set up in least squares fashion and solution is computed by use of the Newton-Raphson iterative technique.

VI. SPECIAL FEATURES: There must be at least as many equations as unknowns.

VII. SUBROUTINES REQUIRED: Subroutine MOPS must be supplied by user to evaluate partial derivatives in addition to an initial guess at solution.

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: ___-0-_____
Is _X_ Is not ___ compatible with Image 100 configuration in present form
_X_ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose _X_ Special purpose ___ Program package
_X_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification _X_ Estimation of Proportion
_X_ Feature Selection _X_ Signature Extension
___ Temporal Sampling ___ Systems Development _X_ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

B. GENERAL MATHEMATICAL LIBRARY

3. APPROXIMATION PACKAGE

I. NAME: Basic Spline Package - Single Variable

II. SOURCE (include coder/person with knowledge of program usage):
Philip W. Smith, Dept. of Math. TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To handle all computations involved in evaluating B-spline functions and their derivatives, including conversion to piecewise polynomial representation.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Package for calculating with B-splines, Carl de Boor, the University of Wisconsin-Madison, Mathematics Research Center, MRC Technical Summary Report #1333, October 1973.
Description: See above reference.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: BSPLDR, BSPLEV, BSPLPP, BSPLVN, BSPLVD, BVALUE, INTERV, PPVALU

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose x Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE BSPLDR

II. SOURCE (include coder/person with knowledge of program usage):
Philip W. Smith

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Constructs divided difference table for B-spline coefficients

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See reference for Basic Spline Package-Single Variable

Description: Equation 2.(2), above reference, is employed.

VI. SPECIAL FEATURES: Cases which would require division by zero because of coincidence of knots are not evaluated: their values are bypassed in the calling routines.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE BSPLEV

II. SOURCE (include coder/person with knowledge of program usage):
Philip W. Smith

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Calculates value of the B-spline and its derivatives (up to a specified order) at a particular x value.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See references for Basic Spline Package-Single Variable

Description: Equation 2.(1), above reference, is used.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: INTERV, BSPLVN

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE BSPLPP

II. SOURCE (include coder/person with knowledge of program usage):
Philip W. Smith

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Converts B-spline representation to piecewise polynomial representation.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See reference for Basic Spline Package-Single Variable

Description: The necessary parameters are calculated by BSPLDR and BSPLEV.

VI. SPECIAL FEATURES: Requires temporary storage "scratch" array allocated in calling program.

VII. SUBROUTINES REQUIRED: BSPLDR, BSPLEV

VIII. DOCUMENTATION: x Available __ Not Available __ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not __ compatible with Image 100 configuration in present form
__ Non-PDP 11/45 FORTRAN
__ Some machine language conversion necessary
__ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
__ General purpose x Special purpose __ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
__ Training __ Classification __ Estimation of Proportion
__ Feature Selection __ Signature Extension
__ Temporal Sampling __ Systems Development x Technique Development
__ Crop Assessment __ Yield Estimation
__ Other (specify) _____

I. NAME: SUBROUTINE BSPLVD

II. SOURCE (include coder/person with knowledge of program usage):
Philip W. Smith

III. PROGRAMMING LANGUAGE:FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Calculates value and derivatives (up to specified order) of all B-splines which do not vanish at the x value.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See reference for Basic Spline Package-Single Variable

Description: Repeated calls are made to routine BSPLVN and an array is built with the different order derivatives at the different pieces of the domain.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: BSPLVN

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose x Special purpose ___Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development x Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE BSPLVN

II. SOURCE (include coder/person with knowledge of program usage):
Philip W. Smith

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Calculates the value of all possibly non-zero B-splines of the particular order (either input or previously determined) at the x value.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See reference for Basic Spline Package-Single Variable

Description: See p.20 above reference to algorithm which this routine incorporates.

VI. SPECIAL FEATURES: An argument parameter switch can be set to use previously computed values where this can save time.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose x Special purpose ___Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development x Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: FUNCTION BVALUE

II. SOURCE (include coder/person with knowledge of program usage):
Philip W. Smith

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Calculates value at x of the specified-order derivative from the B-representation.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See reference for Basic Spline Package-Single Variable

Description: See section 2, above reference.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: INTERV

VIII. DOCUMENTATION: _x_ Available ___ Not Available ___ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is _x_ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose _x_ Special purpose ___ Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development _x_ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE INTERV

II. SOURCE (include coder/person with knowledge of program usage):
Philip W. Smith

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Determines largest subscript for a sequence such that the indexed term is less than a specified value x.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See reference for Basic Spline Package-Single Variable

Description: See p.24, above reference.

VI. SPECIAL FEATURES: An attempt is made to use the previous call's results to minimize search time.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: FUNCTION PPVALU

II. SOURCE (include coder/person with knowledge of program usage):
Philip W. Smith

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Calculates value at x of a specified order derivative from the piecewise polynomial representation.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See reference for Basic Spline Package-Single Variable

Description: Equations 1.(1), above reference, are used.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: INTERV

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose x Special purpose ___Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

B. GENERAL MATHEMATICAL LIBRARY

4. TRANSFORM PACKAGE

A fairly general program which provides the required transform capabilities is available from PAR, Inc.

I. NAME: (MSFAR) Multispectral Fourier Analysis Routines

II. SOURCE (include coder/person with knowledge of program usage):
Jack D. Bryant

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: CDC 6400

IV. PURPOSE: To extract spatial features from multispectral scanner data sets.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: J.A. Smith, G. Hartinger and T. Johnson, "Investigation of Preprocessing Transformations", final report, vol.III, NAS9-12972, Dec. 1974.
Description: See reference above, volumes I and II, also.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
x Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose x Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
x Other (specify) Spatial Recognition Pattern

I. NAME: MERGE

II. SOURCE (include coder/person with knowledge of program usage):
Jack D. Bryant

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: CDC 6400

IV. PURPOSE: To read up to 12 data files and merge selected spectral channels from each file onto one file.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See MSFAR reference, above.

Description: Data handling

VI. SPECIAL FEATURES: Examples: the data set may consist of a large number of channels (e.g.24 channels) or may be a large file (e.g. an ERTS image).

VII. SUBROUTINES REQUIRED: MOVER* GETD, PUTD* SKIPF*
Written in COMPASS SETC GNUM*
(CDC 6400 Assembly Language) CHARS* ZFET*

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
x Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
x Other (specify) Spatial Pattern Recognition

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: CHNL

II. SOURCE (include coder/person with knowledge of program usage):
Jack D. Bryant

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: CDC 6400

IV. PURPOSE: To build a RECOG formatted data file from values read from punched cards for use by the Fourier transform program.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See MSFAR reference, above

Description: Data handling

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: PUTD*, SETC*
*Written in COMPASS
(CDC 6400 Assembly Language)

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
x Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
x Other (specify) Spatial Pattern Recognition

I. NAME: FFT2D

II. SOURCE (include coder/person with knowledge of program usage):
Jack D. Bryant

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: CDC 6400

IV. PURPOSE: FFT2D obtains fast Fourier transforms of the input data streams employing dynamic dimensioning for major arrays.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See MSFAR reference, above

Description: Driver program for FOURT. (Fast Fourier Transform Subroutine)

VI. SPECIAL FEATURES: Two modes of operation are provided: only one aperture within the flight line can be used or the window can be forced to move through the flight line.

VII. SUBROUTINES REQUIRED: DOIT, CORE*, SETC*, CALCP, FOURT, SKIPF*
RELOC, GETO, PUTD*

*Written in COMPASS (CDC 6400 Assembly Language)

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. ___ x ___ Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not x compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

x Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose x Special purpose ___ Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE x Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

x Other (specify) Spatial Pattern Recognition

I. NAME: SUBROUTINE FOUR2

II. SOURCE (include coder/person with knowledge of program usage):
Jack D. Bryant

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: IBM 360

IV. PURPOSE: To obtain the Cooley-Tukey Fast Fourier Transform

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: IEEE Audio Transactions, June 1967, special issue on FFT.

Description: Obtains two-dimensional FFT when the number of data points is $2^N \times 2^M$.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
x Other (specify) Spatial Pattern Recognition

I. NAME: SUBROUTINE FOUR1

II. SOURCE (include coder/person with knowledge of program usage):
Jack D. Bryant

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: IBM 360

IV. PURPOSE: To obtain the Cooley-Tukey Fast Fourier Transform

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: IEEE Audio Transactions, June 1967, special issue on FFT

Description: Obtains one-dimensional FFT when the number of data points is a power of two.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
x Other (specify) Spatial Pattern Recognition

I. NAME: SUBROUTINE FOURT

II. SOURCE (include coder/person with knowledge of program usage):
Jack D. Bryant

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: CDC 6400

IV. PURPOSE: To obtain the Cooley-Tukey Fast Fourier Transform.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: IEEE Audio Transactions, June 1967, special issue on FFT.

Description: This is the fastest and most versatile version of the FFT known.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
x Other (specify) Spatial Pattern Recognition

I. NAME: TRANSF

II. SOURCE (include coder/person with knowledge of program usage):
Jack D. Bryant

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: CDC 6400

IV. PURPOSE: Driver program for user-supplied program TRANS which samples data generated by FFT2D and writes a RECOG formatted tape or file. This may then be analyzed using RECOG or CLUSTD.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See MSFAR reference

Description: Data handling

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: GETD,PUTD*,TRANS(user supplied),CORE*,SETC*, PTAPE

*Written in COMPASS (CDC 6400 Assembly Language)

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is ___Is not x compatible with Image 100 configuration in present form

___Non-PDP 11/45 FORTRAN

x Some machine language conversion necessary

___In language other than FORTRAN. Specify _____

___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___General purpose x Special purpose ___Program package

___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE x Non-LACIE

___Training ___Classification ___Estimation of Proportion

___Feature Selection ___Signature Extension

___Temporal Sampling ___Systems Development ___Technique Development

___Crop Assessment ___Yield Estimation

x Other (specify) Spatial Pattern Recognition

I. NAME: NORMLX

II. SOURCE (include coder/person with knowledge of program usage):
Jack D. Bryant

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: CDC 6400

IV. PURPOSE: Normalizes and rewrites in RECOG format ouput of the circular TRANS subroutine.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See MSFAR reference

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: READTP, GETD, PUTD*

*WRITTEN IN COMPASS (CDC 6400 Assembly Language)

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
x Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
x Other (specify) Spatial Pattern Recognition

I. NAME: WSORT

II. SOURCE (include coder/person with knowledge of program usage):
Jack D. Bryant

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: CDC 6400

IV. PURPOSE: Reads and performs straight or nomalized sort of spatial features obtained by wedge sampling, and produces a new data file, in RECOG format, of sorted spatial features.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See MSFAR reference.

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: SORT, NSORT, RDTAPE, WRTAPE, GETO, PUTD*

*WRITTEN IN COMPASS (CDC 6400 Assembly Language)

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___Is not x compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
x Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose x Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE x Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
x Other (specify) Spatial Pattern Recognition

C. GENERAL STATISTICAL LIBRARY

1. STATISTICAL SUMMARY

I. NAME: SUBROUTINE GROP1(X,N,NG,XMIN,XMAX,F)

II. SOURCE (include coder/person with knowledge of program usage):
Theory & Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: 1108

IV. PURPOSE:

Group data into specified number of equally spaced groups

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Calculate frequencies of each point in each group

VI. SPECIAL FEATURES: XMIN = lower end of the first group
XMAX = upper end of the last group
NG = number of groups

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE MEDIAN(X,N,XMED)

II. SOURCE (include coder/person with knowledge of program usage):
UNIVAC STAT PACK

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Calculate median of a sequence of data points

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT
UNIVAC STAT PACK

Description: Computes rank of median and observations

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE MODE (X,N,XMOD,XB,XM2,XM3,XM4,G1,G2,SKEW,K)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory of Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Calculate estimate of mode of a distribution from sample of data

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description:

VI. SPECIAL FEATURES: Finds central moments, correct 3rd and 4th central moments, calculate coefficient of skewness and excess. Distributions must be unimodal and belong to class of Pearson system distributions (gamma, normal)

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE RANGE(X,N,R)

II. SOURCE (include coder/person with knowledge of program usage):
UNIVAC STAT PACK

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Calculate range of sequence of numbers

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Range = $X_{max} - X_{min}$

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE MNDEV(X,N,IND,D)

II. SOURCE (include coder/person with knowledge of program usage): corrected from STAT PACK
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Calculate mean deviation of an array of data

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT
UNIVAC STAT PACK

Description:

$$\text{deviation} = \frac{1}{N}\sum_{i=1}^{N} |X_i - u|$$

u = median or mean
X_i = i^{th} observation
N = no. of observation

VI. SPECIAL FEATURES:
Option to find deviation from median or arithmetic mean

VII. SUBROUTINES REQUIRED: MEDIAN (if deviation to be found from median)

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE SDEV(X,N,IND,XB,S)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Calculate standard deviation of sequence of data points

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description:

$$S = \frac{\sqrt{\Sigma X^2 - (\Sigma X)^2/N}}{N-1} \quad \text{or} \quad S = \frac{\sqrt{\Sigma X^2 - (\Sigma X)^2/N}}{N}$$

VI. SPECIAL FEATURES: Option if estimate to be used in unbiased or maximum likelihood

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE ORDER(X,N)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Arrange an array in ascending order

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description:

VI. SPECIAL FEATURES: Ordered data returned in X array locations

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

THIS FORM PREPARED BY LEC

I. NAME: PLOT PAC

II. SOURCE (include coder/person with knowledge of program usage):
Ted Keil

III. PROGRAMMING LANGUAGE: FORTRAN/MACRO COMPUTER: 11/45

IV. PURPOSE: To provide the user with a variety of data plotting options (histogram /scattergram/graphs/etc.)

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available ___Not Available ___Will be Available

IX. ___Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_x_General purpose ___Special purpose ___Program package
_x_PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_LACIE _x_Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

THIS FORM PREPARED BY LEC

I. NAME: Binary Search/N-Dimensional Histogram Acquisition

II. SOURCE (include coder/person with knowledge of program usage):
General Electric/Jim Brierly

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: Image-100/PDP-11

IV. PURPOSE: To reduce the time neccessary to acquire N-Dimensional histograms.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See next page

Description: See next page

VI. SPECIAL FEATURES: See next page

VII. SUBROUTINES REQUIRED: None

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: $6,300
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose x Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
x Training x Classification ___ Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

1.2.2 BINARY SEARCH/N-DIMENSIONAL HISTOGRAM ACQUISITION

The time necessary to acquire N-dimensional histograms is normally significantly reduced using this program. A binary search technique is employed to (potentially) reduce the number of cell interrogations required for signature generation by testing large volumes of feature space rather than each indivicual cell. This is accomplished by successively bisecting each feature space axis, each time testing each produced volume for non-zero pixel counts. Any volume with a zero pixel count is subsequently ingored, and in most cases will enable a substantial reduction in the number of single cells otherwise requiring consideration. Any volume with a non-zero count will be further subdivided until the required resolution is reached. The pixel counts for the smallest cells are recorded as is done in the N-D Histogram.

Use of this program generally results in orders-of-magnitude reductions in histogram acquistion time, resulting in N-dimensional training being more attractive as an analysis tool. In addition, the operation of post-training functions such as semi-supervised cluster analysis (described in paragraph 1. 4. 2) becomes more efficient.

C. GENERAL STATISTICAL LIBRARY

2. DENSITIES & DISTRIBUTIONS PACKAGE

I. NAME: FUNCTION PHINV (P)

II. SOURCE (include coder/person with knowledge of program usage):
JSC THeory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Inverse of normal distribution function

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Given mean 0 and variance 1, using Newton Raphson iterations

VI. SPECIAL FEATURES: Checks probability P for validity and prints error message if P is invalid.

VII. SUBROUTINES REQUIRED:

PHI

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: DOUBLE PRECISION FUNCTION DPHI(X)
FUNCTION PHI(X)

II. SOURCE (include coder/person with knowledge of program usage):
S.W. Kahng, JSC/LEC, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Normal probability integral for real X

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description:

$$\frac{1}{\sqrt{2PI}} \int_{-oo}^{x} \exp\ (-t^2/2)dt$$

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: REAL FUNCTION FISH(F,N1, N2)

II. SOURCE (include coder/person with knowledge of program usage):
corrected from UNIVAC STAT-PACK; JSC Theory and Analysis Office, Houston.

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Approximate Fisher's f-distribution

V. ALGORITHM/TECHNIQUE (short description; include reference if available)
JSC STAT CAT
Reference: George Neel, Larry Whitehead, Robert Bottenburg, "Calculation of the percentage points of the F-distribution," Technical Documentary Report PFL-TDR-64-16, 6570th Personal Research Lab., Aerospace Medical Div., Air Force Systems Command, Lackland AFB, Texas
Description:

VI. SPECIAL FEATURES: N1 and N2 $\geq$ 1

VII. SUBROUTINES REQUIRED: PHI

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: DOUBLE PRECISION FUNCTION DERF(X)
FUNCTION ERF(X)

II. SOURCE (include coder/person with knowledge of program usage):
S.W. Kahng, JSC/LEC, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Error function

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description:

$$\frac{2}{\sqrt{PI}} \int_0^x \exp(-t^2)\, dt$$

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: DOUBLE PRECISION FUNCTION DERFC(X)
FUNCTION ERFC(X)

II. SOURCE (include coder/person with knowledge of program usage):
S.W. KAHNG, JSC/LEC, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Complimentary
Error function

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: 1-ERF(K)

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: _x_ Available ___ Not Available ___ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: REAL FUNCTION CHI2 (X,V)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Approximate χ^2 distribution

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Given a point and degrees of freedom, approximate value of the χ^2 distribution at the point
Method used depends on values of the point and the degree of freedom.

VI. SPECIAL FEATURES: Provision for overflow
$X \geq 0.0$
uses CBRT function

VII. SUBROUTINES REQUIRED: ZIP (calls FACTOR)
OVERFL
PHI

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: FUNCTION EXPAN(N,T)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Approximate student's t-distribution

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Using series expansion method, given degrees of freedom

VI. SPECIAL FEATURES: Values of N decide which equations to use.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: REAL FUNCTION POIS(N,XMU)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Value of Poisson distribution function

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: $POIS(N,XMU) = e^{-XMU} \sum_{i=0}^{N} \frac{XMU^i}{i!}$; XMU = mean of distribution

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: FUNCTION FISHIN (ALPHA,N1,N2)

II. SOURCE (include coder/person with knowledge of program usage):
Corrected from UNIVAC STAT PACK

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Inverse Fisher's distribution

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: ref. Abramowitz and Stegun, Handbook of Mathematical Function, p.947. National Bureau of Standards.

VI. SPECIAL FEATURES: $0 \leq ALPHA < 1$, ALPHA is the confidence coefficient.

VII. SUBROUTINES REQUIRED: FISH PHINV

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: REAL FUNCTION BIN(N,P,M)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Value of binomial distribution function

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description:

VI. SPECIAL FEATURES: For values of M > 1000, PHI is called in the calculations

VII. SUBROUTINES REQUIRED:
PHI
ZOT

VIII. DOCUMENTATION: _X_ Available ___ Not Available ___ Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: FUNCTION HYTRIC(K,N,N1,NR)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Hypergeometric distribution

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Calculate probability that a random variable with a hypergeometric distribution is less than or equal to a given value

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

FCTRLG
FACTOR

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: REAL FUNCTION BETINC(X,A,B)

II. SOURCE (include coder/person with knowledge of program usage): corrected from UNIVAC STAT PACK

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: INCOMPLETE BETA DISTRIBUTION

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT
UNIVAC STAT PACK

Description: Compute probability that a random variable, distributed as the incomplete Beta function with given values of parameters, is less than or equal to a given value.

VI. SPECIAL FEATURES: The Modified Jacobi Quadrature formula is used in computing integrals. Uses CBRT function

VII. SUBROUTINES REQUIRED:

PHI
CHI2

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: REAL FUNCTION GAMIN(X,A)

II. SOURCE (include coder/person with knowledge of program usage):
UNIVAC STAT PACK

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Incomplete gamma function

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT
UNIVAC STAT PACK

Description:

$$P(A,X) = \frac{1}{\Gamma(A)} \int_0^X e^{-t}\, t^{A-1}\, dt \text{ with } P_N(A,X) = X^A\, e^{-X} \sum_{n=0}^{N} \frac{X^n}{\Gamma(A+n+1)} + R_N$$

where N is such that $\frac{P_{N-1}(A,X)}{P_N(A,X)} \leq 10^{-6}$

VI. SPECIAL FEATURES:

A and X > 0

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. __XSoftware available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: REAL FUNCTION STUDIN(N,P)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Inverse student's t-value

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Given degrees of freedom and significance level, using Newton Raphson iterations

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

FACTOR PHINV
EXPAN

VIII. DOCUMENTATION: _X_ Available ___ Not Available ___ Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: REAL FUNCTION ZOT(N)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: ZOT = ALOG(N!)

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Calls FACTOR with $\alpha = N + 1$

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:
FACTOR

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: FUNCTION RANDOM

II. SOURCE (include coder/person with knowledge of program usage):
Richard Rosencranz, JSC Engineering Applications, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Generate random numbers from uniformly distributed set

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description:

VI. SPECIAL FEATURES: Option to return number from uniformly distributed set or number that is a function of input
Used mainly as a random starting point for cyclical set of numbers in ZØR function.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: REAL FUNCTION ZIP(A)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Compute $\ln_e$ of the gamma function

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Calls FACTOR with $\alpha = A$

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

FACTOR

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: REAL FUNCTION ZARF(Z)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Compute complete gamma function $\Gamma(Z)$

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Calls FACTOR with $\alpha = Z + 1.0$

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

FACTOR

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. __X__Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. **NAME:** FUNCTION KPSNSM (AS)
FUNCTION KPSNLG (AL)

II. **SOURCE (include coder/person with knowledge of program usage):**
JSC Theory and Analysis Office, Houston

III. **PROGRAMMING LANGUAGE:** FORTRAN V **COMPUTER:** 1108

IV. **PURPOSE:** random numbers from a Poisson distribution.

V. **ALGORITHM/TECHNIQUE (short description; include reference if available)**

Reference: JSC STAT CAT

Description: KPSNSM: $\prod_{i=1}^{k+1} \mu_i < e^{-\mu}$

KPSNLG: $\sum_{i=1}^{k+1} \ln \mu_i < -\mu$

VI. **SPECIAL FEATURES:** Use KPSNLG if AL is greater than 88.028. If ZØR is initialized with a large odd number in the calling program, the sequence of random numbers will be repeated.

VII. **SUBROUTINES REQUIRED:** ZØR

VIII. **DOCUMENTATION:** x Available __ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE BIN2 (N,I,BINCØ,D7)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Compute binomial coefficient.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Compute N things taken 1 at a time.

$$\binom{N}{I} = \frac{N!}{I!(N-I)!}$$

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: Values of I and N determine the calculations done.

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE OVERFL(I)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Checks values for overflow condition

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: Checks for overflow condition and return a one if overflow occurred

VI. SPECIAL FEATURES: OVERFL is part of 1108 system

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available _X_ Not Available ___Will be Available

IX. _X_Software available off-the-shelf. Approximate Cost: _____

Is___Is not___compatible with Image 100 configuration in present form

___Non-PDP 11/45 FORTRAN

___Some machine language conversion necessary

___In language other than FORTRAN. Specify _____

__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___General purpose___Special purpose___Program package

___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION:___LACIE___Non-LACIE

___Training___Classification___Estimation of Proportion

___Feature Selection___Signature Extension

___Temporal Sampling___Systems Development___Technique Development

___Crop Assessment___Yield Estimation

___Other (specify) _____

C. GENERAL STATISTICAL LIBRARY

3. REGRESSION PACKAGE

C. GENERAL STATISTICAL LIBRARY

4. STATISTICAL TESTS

COMPUTER PROGRAM IDENTIFICATION FORM

I. **NAME:** SUBROUTINE TTEST(A,N,M,NN,MM,X,AL,IND,S,US,AF,AT)

II. **SOURCE (include coder/person with knowledge of program usage):**
JSC Theory and Analysis Office, Houston

III. **PROGRAMMING LANGUAGE:** FORTRAN V **COMPUTER:** 1108

IV. **PURPOSE:** Hotelling's T^2 test on means.

V. **ALGORITHM/TECHNIQUE (short description; include reference if available)**

Reference: JSC STAT CAT

Description: Test at a desired confidence level the null hypothesis that the mean vector of a set of observations equals a given vector.

VI. **SPECIAL FEATURES:** Variable dimensioning of arrays. Acceptance or rejection message is printed and option is available to print output.

VII. **SUBROUTINES REQUIRED:** CØVARI GINV2M FISHIN

VIII. **DOCUMENTATION:** _x_ Available ___ Not Available ___ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE CØVARI (A,N,M,MM,NN,S,X)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Compute covariances between observed variables.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description:

$$S(I,J) = \left(\frac{1}{N-1}\right) \sum_{K=1}^{N} \sum_{I=1}^{M} \sum_{J=1}^{M} \left[A(K,I) - X(I)\right] \left[A(K,J) - X(J)\right]$$

VI. SPECIAL FEATURES:
A is a matrix where column i contains the ovservations for variable i. N and M ≥ 2

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE ANOV1(Y,N,J,I,R,S,SS,NDF,SM,F,PF,$K,IND,YH)

II. SOURCE (include coder/person with knowledge of program usage): corrected from UNIVAC STAT PACK
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: One way analysis of variance

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: One way analysis of variance with unequal number of replications in each cell; computes all sums of squares, degrees of freedom, mean squares, F-levels and probabilities that F-levels are exceeded.

VI. SPECIAL FEATURES: Control may be returned to a labelled statement in calling program in event of overflow
Option flag specifies lines to be printed.

VII. SUBROUTINES REQUIRED: FISH

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE ANOVA2(Y,N,NI,NJ,NK,B,R,SS,NDF,SM,F,PF, $K,IFR,YH)

II. SOURCE (include coder/person with knowledge of program usage): corrected from UNIVAC STAT PACK
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Two way analysis of variance

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: 2 way analysis of variance with an equal number of replications in each cell; computes all sums of squares, degrees of freedom, mean squares, F-levels and probabilities that F-levels are exceeded.

VI. SPECIAL FEATURES: If overflow occurs, control may be returned to some labelled statement in the calling program
Option flag determines type of output desired.

VII. SUBROUTINES REQUIRED: FISH

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. __XSoftware available off-the-shelf. Approximate Cost: _____
Is___Is not___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose___Special purpose___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE___Non-LACIE
___Training___Classification___Estimation of Proportion
___Feature Selection___Signature Extension
___Temporal Sampling___Systems Development___Technique Development
___Crop Assessment___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE RBANOV(Y,N,NB,NT,NR,B,R,SS,NDF,SM,F,PF, $ K)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Analysis of variance on a randomized block design

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Analysis of variance on a randomized block design with an equal number of replications in each experimental unit; computes all sums of squares, degrees of freedom, mean squares, F-levels and probabilities that the F levels are exceeded.

VI. SPECIAL FEATURES: If overflow occurs, control will be returned to a labelled statement in the calling program

VII. SUBROUTINES REQUIRED:

BTALOG
PROBLY

VIII. DOCUMENTATION: _X_ Available ___ Not Available ___ Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose ___ Special purpose ___ Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: FUNCTION ZOR(N)

II. SOURCE (include coder/person with knowledge of program usage):
Richard Rosencranz, JSC Engineering Applications, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Random number generator

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Uses uniform distribution set between 0 and 1 or normal distribution with mean 0 and variance 1

VI. SPECIAL FEATURES: Flag to choose distribution set
Calling program should declare ZOR to be an ABNORMAL FUNCTION

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: _X_ Available ___ Not Available ___ Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE KOLSMR(X,N,F,KW,KN,D)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Kolmogorov-Smirnov test of goodness of fit

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Test goodness of fit of data to a specified theoretical cumulative distributive function

VI. SPECIAL FEATURES: Cumulative distributive function may be applied to raw or normalized data; prints output
Print option specifies lines to be printed out.
Function option specifies type of function F is to be used.

VII. SUBROUTINES REQUIRED:

ORDER

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE FACTOR (ALPHA,EXPAN,YEXPAN)

II. SOURCE (include coder/person with knowledge of program usage):
JSC Theory and Analysis Office, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108

IV. PURPOSE: Approximate complete gamma (factorial) function

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: JSC STAT CAT

Description: Evaluate gamma function and $\ln_e$ of the complete gamma function

VI. SPECIAL FEATURES: Value of alpha determines equations used.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

D. PATTERN RECOGNITION LIBRARY

1. CLUSTERING PACKAGE

COMPUTER PROGRAM IDENTIFICATION FORM

THIS FORM PREPARED BY LEC

I. NAME: Semi-supervised Cluster Analysis

II. SOURCE (include coder/person with knowledge of program usage):
General Electric/Jim Brierly

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: IMAGE-100/PDP-11

IV. PURPOSE: To determine the feature space location of homogenous clusters from the results of N-dimensional histogram analysis.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See next page

Description: See next page

VI. SPECIAL FEATURES: See next page

VII. SUBROUTINES REQUIRED: None

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: $6,049
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose x Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
x Training x Classification ___ Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

1.4.2 SEMI-SUPERVISED CLUSTER ANALYSIS

The function of this program is to determine, if possible, the approximate feature space location of homogeneous cell groupings (clusters) from the results of N-dimensional histogram analysis, in a semi-supervised manner. Using the results of a previous N-dimensional training step, this program attempts to categorize the N-D results into a user-specified number of clusters. A migrating means technique is used for partitioning feature space with the means initially set to arbitrary starting values. The program then iterates through a succession of new partitions to determine the optimum assignment of each cell to one of the number of clusters specified by the user. The user may stop the program at any point and accept the results to-date, or may elect to let the program run to conclusion. In either case, the program displays the results on the Graphics Display Terminal. It is possible that an acceptable solution may not be reached for the given number or any other number of specified clusters. The program will terminate after fifty iterations.

COMPUTER PROGRAM IDENTIFICATION FORM

THIS FORM PREPARED BY LEC

I. NAME: DRIVER PROGRAM (ISOCLS)

II. SOURCE (include coder/person with knowledge of program usage):
R. MINTER/LEC also E. KAN/LEC

III. PROGRAMMING LANGUAGE: FORTRAN V SLEUTH COMPUTER: UNIVAC 1108 EXEC 2

IV. PURPOSE: Driver program to perform iterative clustering

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: "Computer Program Documentation, ISOCLS, Program C094" R. Minter, LEC, Report #CPD202, Oct. 1972. "User Documentation EOD-LARSYS, Program Q619" R. Minter, LEC, Report #CPD406, LEC-3984, Nov. 1974.

Description: Iteratively group data into homogenous nominal-sized clusters, the nominal size is to be preset by users.

VI. SPECIAL FEATURES: See references

VII. SUBROUTINES REQUIRED: TDATE, SETUP, TAPERD, ISODAT, COVARR, PCHSTA, CHAIN, PRINT, DASTAP (See next page)

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is x Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other han FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose ___ Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

x Training ___ Classification ___ Estimation of Proportion

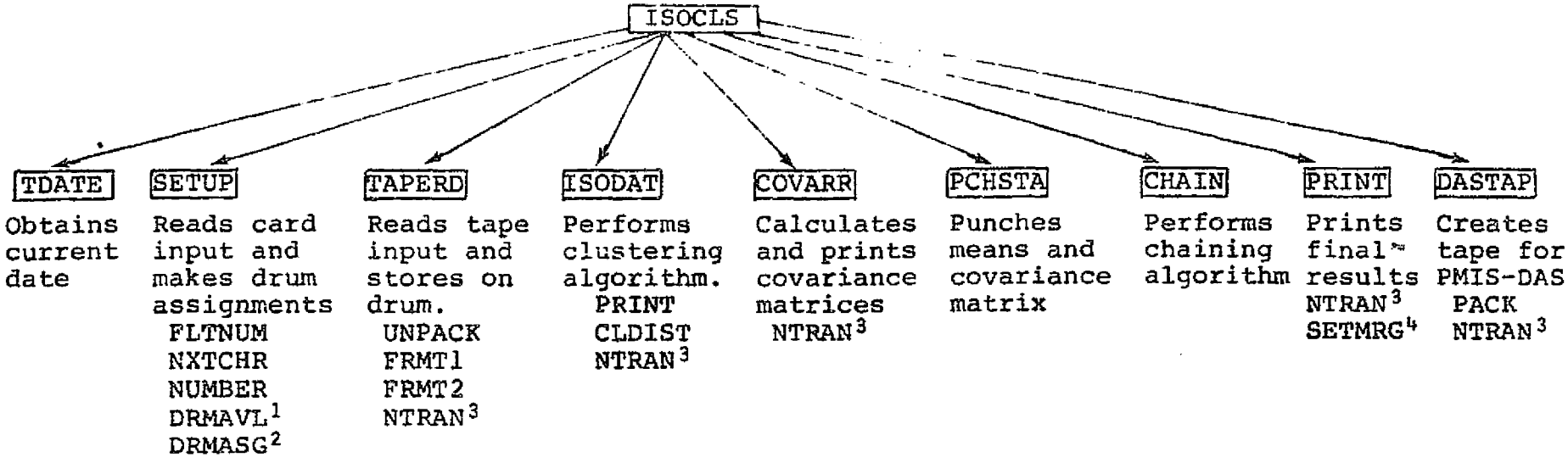
___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

General Flow of the Program Isocls



1 System routine which returns the number of words available on FH432 and FH1782 drums.

2 System routine which assigns specific word length to drum unit.

3 System binary I/O routine.

4 System routine which sets the margin at the top and bottom of the page.

I. NAME: SUBROUTINES TDATE, SETUP, etc. (See first page of ISOCLS)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: COMPUTER:

IV. PURPOSE:

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available ___Not Available ___Will be Available

IX. ___Software available off-the-shelf. Approximate Cost: _____
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___LACIE ___Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

D. PATTERN RECOGNITION LIBRARY

2. CLASSIFICATION PACKAGE

Maximum likelihood classification algorithms are being implemented on the Image 100 System by LEC.

COMPUTER PROGRAM IDENTIFICATION FORM
THIS FORM PREPARED BY LEC

I. NAME: ELLTAB

II. SOURCE (include coder/person with knowledge of program usage):
NASA/MTF Clay Jones

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: UNIVAC 1108

IV. PURPOSE: Classify multispectral scanner data.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See next page

Description: See next page

VI. SPECIAL FEATURES: See next page

VII. SUBROUTINES REQUIRED: None

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: 0

Is x Is not ___ compatible with Image 100 configuration in present form

_x_ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose ___ Special purpose ___ Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

___ Training x Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

AN IMPROVED VERSION OF THE TABLE LOOK-UP ALGORITHM FOR PATTERN RECOGNITION*

W. G. Eppler

Lockheed Electronics Company†
Houston, Texas

ABSTRACT

The Table Look-Up Approach to pattern recognition has been used for 3 years at several research centers in a variety of applications. A new version has been developed which is faster, requires significantly less core memory, and retains full precision of the input data. The new version can be used on low-cost minicomputers having 32K words (16 bits each) of core memory and fixed-point arithmetic; no special-purpose hardware is required. An initial FORTRAN version of this system can classify an ERTS computer-compatible tape into 24 classes in less than 15 minutes.

IMPLEMENTATION OF AN ADVANCED TABLE LOOK-UP CLASSIFIER FOR LARGE AREA LAND-USE CLASSIFICATION

Clay Jones

Johnson Space Center
Earth Resources Laboratory
National Aeronautics and Space Administration
Bay St. Louis, Mississippi 39520

ABSTRACT

Software employing Eppler's improved table look-up approach to pattern recognition has been developed, and results from this software are presented. The look-up table for each class is a computer representation of a hyperellipsoid in four dimensional space. During implementation of the software Eppler's look-up procedure was modified to include multiple ranges in order to accommodate hollow regions in the ellipsoids. In a typical ERTS classification run less than 6000 36-bit computer words were required to store tables for 24 classes. Classification results from the improved table look-up are identical with those produced by the conventional method, i.e., by calculation of the maximum likelihood decision rule at the moment of classification. With the new look-up approach an entire ERTS MSS frame can be classified into 24 classes in 1.3 hours, compared to 22.5 hours required by the conventional method. The new software is coded completely in FORTRAN to facilitate transfer to other digital computers.

COMPUTER PROGRAM IDENTIFICATION FORM

THIS FORM PREPARED BY LEC

I. NAME: Maximum Likelihood Resolution

II. SOURCE (include coder/person with knowledge of program usage):
General Electric/Jim Brierly

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: IMAGE-100/PDP-11

IV. PURPOSE: To resolve conflicts between overlapping spectral signatures.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See next page

Description: See next page

VI. SPECIAL FEATURES: See next page

VII. SUBROUTINES REQUIRED: None

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: $6,286
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose x Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

1.3.1 MAXIMUM LIKELIHOOD RESOLUTION

This program permits conflicts between overlapping spectral signatures to be resolved by assigning spectral cells to the class which has highest probability, where probability is based on the frequency of occurrence of a given multispectral pixel value normalized with respect to the training area.

The user first specifies two signature files (results of N-Dimensional Histogram Acquisition) presumably generated from the same image data. The option of simultaneous theme modification is available and if desired, the one or two corresponding themes tracks are also specified. The image data must also be stored in the Image Memory Unit.

The two signature files are compared in feature space, and any areas of overlap are examined. The overlapping cells are assigned to one or the other signature on the basis of maximum likelihood. That is, for any feature space cell, the normalized number of pixels having that cell's coordinates is computed for each signature, and the largest one is retained in its file while the other file's cell is deleted; thus, assuring that each cell is assigned to only one signature file. The themes, if desired, are also modified accordingly by deleting the pixels corresponding to the deleted cells.

D. PATTERN RECOGNITION LIBRARY

3. FEATURE SELECTION PACKAGE

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: PROGRAM UH Linear Feature Selection

II. SOURCE (include coder/person with knowledge of program usage):
J. A. Quirein, LEC-JSC Houston; H. P. Decell/R. Teun, Math. Dept., UH

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: 1108/EXEC 8
360/67

IV. PURPOSE: Linear feature selection to minimize loss of separability among classes.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: H.P. Decell & J.A. Quirein, "An Iterative Approach to the Feature Selection," Univ. of Houston Report 26, March 1973, NAS 9-12777. Kenneth Baker, "Users Guide to the Univ. of Houston Linear Feature Selection Program," NASA, 1973. Rebecca Teun, "Addendum to Users Guide," UH Report 33, July, 1974 NAS 9-12777

Description: Linear transformation B of measurement x such that the average transformed divergence is maximized for all interclass pairs.

VI. SPECIAL FEATURES: Reduces dimensions of data to be classified from n to k. Uses Davidon Iterator to find best B.

VII. SUBROUTINES REQUIRED: See tree on p. 1a.

DAVIDN	SHUTLE	MPROD	EIGEN	TRANDV
CUBIC	CHLSKY	XPROD	BHATCH	
FINT	MVPR	HALM	DMVPR	

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not X compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose X Special purpose X Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE X Non-LACIE

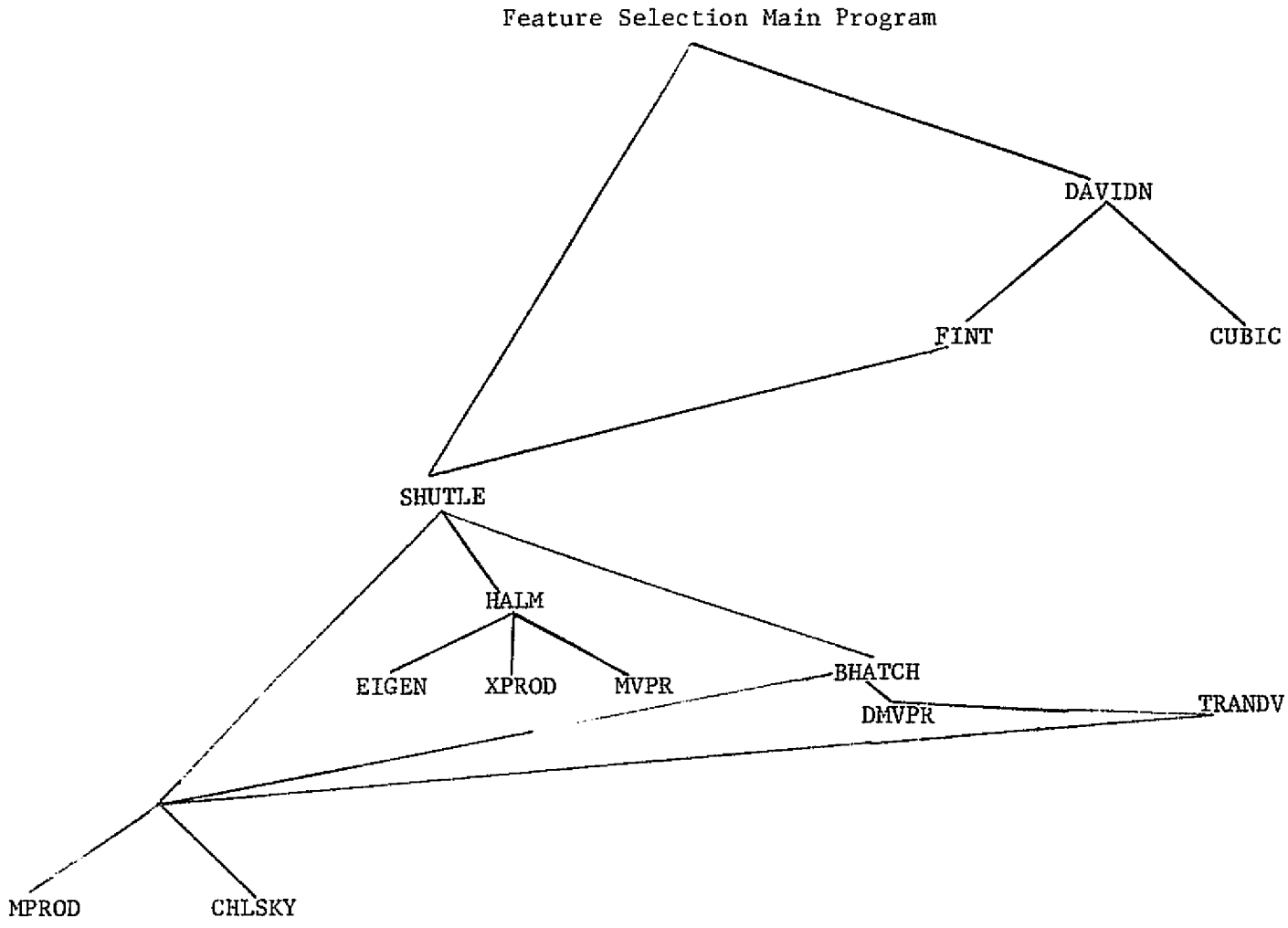
___ Training ___ Classification ___ Estimation of Proportion

X Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____


Feature Selection Main Program
DAVIDN
FINT
CUBIC
SHUTLE
HALM
EIGEN
XPROD
MVPR
BHATCH
DMVPR
TRANDV
MPROD
CHLSKY

I. NAME: SUBROUTINE DAVIDN

II. SOURCE (include coder/person with knowledge of program usage):
Ivan Johnson, JSC/MPAD, Houston

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: 1108/EXEC B
360/67

IV. PURPOSE: Davidon-Fletcher-Powell iterator

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Ivan Johnson, "Impulsive Orbit Transfer Optimization by an Accelerated Gradient Method," Journal of Spacecraft and Rockets, Vol. 6, No. 5, May 1969.
Description: Davidon- Fletcher-Powell optimization method to find best k linear combination B matrix.

VI. SPECIAL FEATURES: Optimal B is derived iteratively from an initial guess B and gradient.

VII. SUBROUTINES REQUIRED: CUBIC, FINT, SHUTLE

VIII. DOCUMENTATION: ___Available _x_ Not Available ___Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is ___Is not _x_ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_x_ General purpose ___Special purpose ___Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___Training ___Classification ___Estimation of Proportion
_x_ Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development _x_ Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE FINT (FNT,IPART)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE: Compute numerical partial derivatives.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See DAVIDN

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: SHUTLE

VIII. DOCUMENTATION: ___Available _x_ Not Available ___Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is ___Is not _x_ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_x_ General purpose ___ Special purpose ___ Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___Training ___Classification ___Estimation of Proportion
_x_ Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development _x_ Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

C3

I. NAME: SUBROUTINE CUBIC(XX,YY,XMIN2)

II. SOURCE (include coder/person with knowledge of program usage):
Ivan Johnson, JSC/MPAD, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE: Cubic fit technique.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See DAVIDN

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available _x_ Not Available ___Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is ___Is not _x_ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_x_ General purpose ___ Special purpose ___ Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___Training ___Classification ___Estimation of Proportion
_x_ Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development _x_ Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE SHUTLE(FNT,IPART)

II. SOURCE (include coder/person with knowledge of program usage):
J. Quirein, LEC/JSC; H.P. Decell, R. Teun, Math. Dept. UH

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE: Calculate interclass divergences and probability of misclassification bound.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: J.A. Quirein,"Iterative Approach to Feature Selection Problem," UH Report 26, March 1973, NAS9-12777

Description:See above report for equations used.

VI. SPECIAL FEATURES:Option to find Bhattacharyya bound and transformed average divergence.

VII. SUBROUTINES REQUIRED: MPROD, CHLSKY, HALM, BHATCH, TRANDV

VIII. DOCUMENTATION: ___Available _x_ Not Available ___Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is ___Is not _x_ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose _x_ Special purpose ___Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___Training ___Classification ___Estimation of Proportion
_x_ Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development _x_ Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE CHLSKY (XTEMP, XUP, CHI, K)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: 1108
360/67

IV. PURPOSE: Invert a positive definite symmetric matrix.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: XTEMP is factored into 2 upper triangular matrices that are inverted.

VI. SPECIAL FEATURES: Option to check inverse by multiplying the inverse by the original matrix and printing the result.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: __Available _x_ Not Available __Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____

Is _x_ Is not __ compatible with Image 100 configuration in present form

__ Non-PDP 11/45 FORTRAN

__ Some machine language conversion necessary

__ In language other than FORTRAN. Specify _____

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

_x_ General purpose __ Special purpose __ Program package

_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE

__ Training _x_ Classification __ Estimation of Proportion

_x_ Feature Selection __ Signature Extension

__ Temporal Sampling __ Systems Development _x_ Technique Development

__ Crop Assessment __ Yield Estimation

__ Other (specify) _____

I. NAME: SUBROUTINE MVPR(XTEMP, VECT, XVECT, KDM, KN)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE: Post-multiply m×n matrix by n×1 vector.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: XTEMP × VECT = XVECT

VI. SPECIAL FEATURES: Single precision. Dimensions less than or equal to 12.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available _x_ Not Available ___Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is _x_ Is not ___ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_x_ General purpose ___ Special purpose ___ Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE MPROD(XX,YY,ZZ,K1,K2,K3)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE: Matrix multiplication.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: XX × YY = ZZ

VI. SPECIAL FEATURES: Double Precision: Dimensions must be less than OR equal to 12.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available _x_ Not Available ___Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is _x_ Is not ___ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_x_ General purpose __ Special purpose ___ Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE XPROD(XX,YY,ZZ,K1,K2,K3)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE: Single precision matrix multiplication,

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: XX×YY=ZZ

VI. SPECIAL FEATURES: Dimensions must be less than or equal to 12.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___ Available _x_ Not Available ___ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is _x_ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_x_ General purpose ___ Special purpose ___ Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE HALM(N, IFLAG, ERFT)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE: Pairwise bounds on probability of misclassification.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See references for UH feature selection.

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: EIGEN, XPROD, MVPR

VIII. DOCUMENTATION: ___Available _x_ Not Available ___Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____
Is ___Is not _x_ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose _x_ Special purpose ___Program package
_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE
___Training _x_ Classification ___Estimation of Proportion
_x_ Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development _x_ Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE EIGEN(AA,N,MV,A,E,R)

II. SOURCE (include coder/person with knowledge of program usage):
Jane Montgomery, TRW Systems

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE:

eigenvalues and eigenvectors of a real symmetric matrix

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: Von Neumann, "Mathematical Methods for Digital Computers," Ed. A. Ralston and H. S. Wilf, John Wiley and Sons, New York, chapter 7, 1962.

Description:
Jacobi method of diagonalization

VI. SPECIAL FEATURES:
option to compute eigenvalues only

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available _X_Not Available ___Will be Available

IX. _X_Software available off-the-shelf. Approximate Cost: _____
Is _X_Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_X_ General purpose ___Special purpose ___Program package
_X_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _X_ LACIE _X_ Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development _X_ Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE BHATCH(F.NT,IPART)

II. SOURCE (include coder/person with knowledge of program usage):
J. A. Quirein, LEC/JSC, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE:
compute minimum average Bhattacharyya bound on the probability of misclassification

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: UH feature selection

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:
MPROD
CHLSKY
DMVPR

VIII. DOCUMENTATION: ___Available _X_Not Available ___Will be Available

IX. _X_Software available off-the-shelf. Approximate Cost: _____
Is ___Is not _X_ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose _X_Special purpose ___Program package
_X_PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _X_LACIE _X_Non-LACIE
___Training ___Classification ___Estimation of Proportion
_X_Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE DMVPR(XTEMP, VECT, XVECT, KDM,KN)

II. SOURCE (include coder/person with knowledge of program usage):

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE:

multiply matrix by vector

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:
UH feature selection

Description:
XTEMP * VECT = XVECT

VI. SPECIAL FEATURES:

double precision

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: ___Available _X_ Not Available ___Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is _X_ Is not ___ compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_X_ General purpose ___ Special purpose ___ Program package
_X_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _X_ LACIE _X_ Non-LACIE
___Training ___Classification ___Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development _X_ Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE TRANDV

II. SOURCE (include coder/person with knowledge of program usage):
J. A. Quirein, LEC/JSC, Houston

III. PROGRAMMING LANGUAGE: FORTRAN V COMPUTER: 1108
360/67

IV. PURPOSE:
minimum average transformed divergence

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: UH feature selection

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:
MPROD
CHLSKY
DMVPR

VIII. DOCUMENTATION: ___Available _X_ Not Available ___Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is___Is not _X_compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose _X_ Special purpose ___Program package
_X_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _X_ LACIE _X_ Non-LACIE
___Training ___Classification ___Estimation of Proportion
_X_Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: LFSPMC : Linear Feature Selection Probability of Misclassification

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman,Jr. / Bruce D. Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: To compute a single linear combination of features which minimizes the probability of misclassification

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: L.F. Guseman,Jr. B. Charles Peters, Jr., and Homer F. Walker, On minimizing the probability of misclassification for linear feature selection, Ann. Statist. 3(1975), 1-8

Description: See program package documentation LFSPMC: Linear Feature Selection Program Using Probability of Misclassification, Contract NAS-9-13894-1S, Report #3, Dept. of Math. Texas A&M University

VI. SPECIAL FEATURES:
COMPLETE PROGRAM PACKAGE: INDIVIDUAL SUBROUTINES AND DRIVER ATTACHED.

VII. SUBROUTINES REQUIRED:

See subroutine tree on 1a of 18

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not x compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose x Special purpose x Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

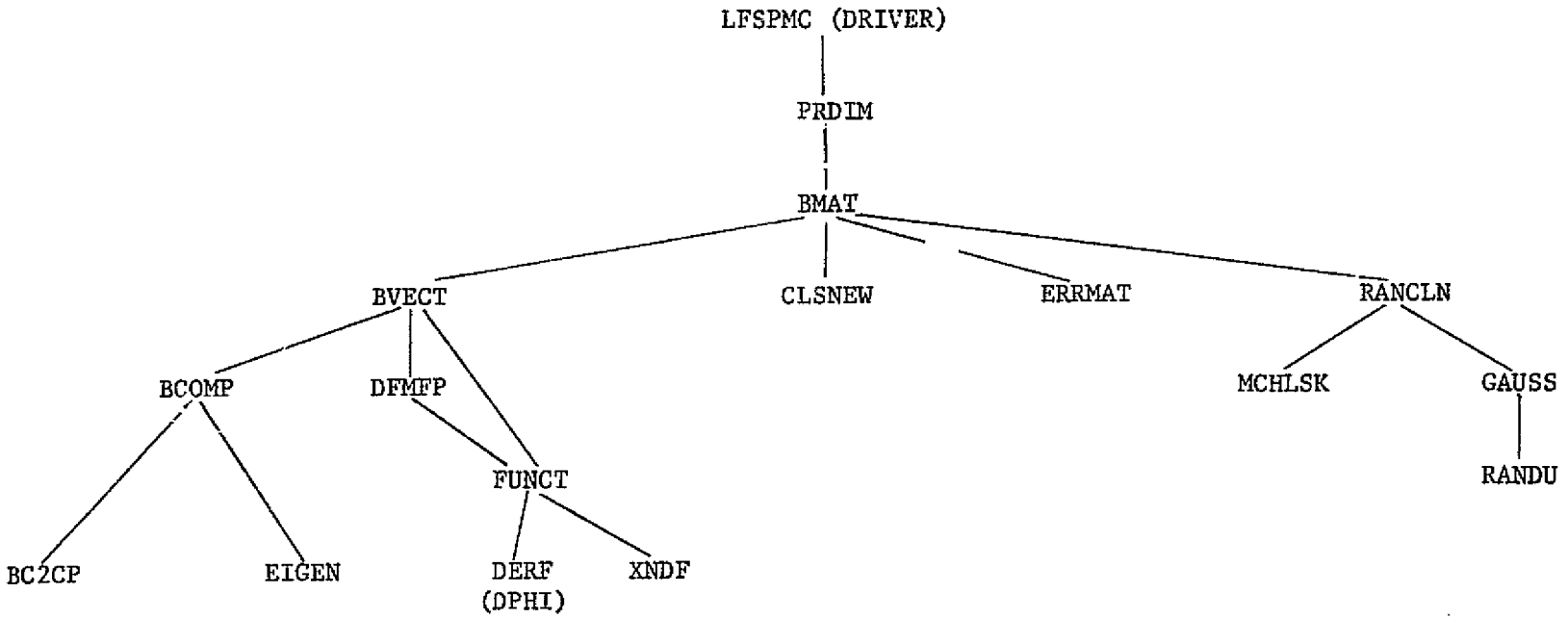
___ Training ___ Classification ___ Estimation of Proportion

x Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____


LFSPMC (DRIVER)
PRDIM
BMAT
BVECT
CLSNEW
ERRMAT
RANCLN
BCOMP
DFMFP
MCHLSK
GAUSS
FUNCT
RANDU
BC2CP
EIGEN
DERF
(DPHI)
XNDF

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: DRIVER PROGRAM (LFSPMC)

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: Driver program to set common dimensions throughout LFSPMC Package

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See previous LFSPMC

Description: Sets value MX for maximum numbers of classes and value NX for maximum number of features. Provides maximum string lengths.

VI. SPECIAL FEATURES: MX and NX must not be exceeded during any run for a given compilation.

VII. SUBROUTINES REQUIRED: PRDIM

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not x compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose x Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE ___ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

x Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE PRDIM

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To provide dimensioning information to the subroutines of LFSPMC, effectively simulating object-time dimensioning.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: LFSPMC

Description: Starting addresses of subset arrays contained within single, large, previously-defined one-dimensional arrays are computed.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:
BMAT

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not x compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose x Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

x Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE BMAT

II. SOURCE (include coder/person with knowledge of program usage):
L. F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Main Driving Routine for LFSPMC. It performs all input and output of class statistics, executes user specified program options.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: LFSPMC

Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:
BVECT, CLSNEW, ERRMAT, RANCLN

VIII. DOCUMENTATION: _x_ Available ___ Not Available ___ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not _x_ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose _x_ Special purpose ___ Program package

_x_ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _x_ LACIE _x_ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

_x_ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE BVECT

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Compuce the vector B which minimizes the probability of misclassification function

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: LFSPMC

Description: BVECT is a driver routine. It inputs iteration parameters, either inputs a starting value for the B vector or calls for its computation (BCOMP), calls for iteration on B for function minimization computation (DFMFP), and calls for computation and output of the final (lower case) function value. (FUNCT.)

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:
BCOMP, DFMFP, FUNCT

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not x compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose x Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

x Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE BCOMP

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER:IBM 360/65

IV. PURPOSE: Compute the initial B vector for input to the minimization iteration routine.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: LFSPMC

Description: Determines iterative soution of a special case of the M-class problem (equal covariances) and uses this as starting vector

VI. SPECIAL FEATURES:
No computation is performed in the special case of two classes with equal a priori probabilities; it merely calls routine BC2CP.

VII. SUBROUTINES REQUIRED:
BC2CP, EIGEN

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___Is not x compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose x Special purpose ___Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___Training ___Classification ___Estimation of Proportion
x Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE BC2CP

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Compute initial vector Bo for input to the minimization iteration routine - 2 class case with equal a priori probabilities

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: LFSPMC

Description:

$$Bo=(\mu_1-\mu_2)^T\ (\Sigma_1+\Sigma_2)^{-1}$$

VI. SPECIAL FEATURES:
Called only in the special case of two classes with equal a priori probabilities

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___Is not x compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose x Special purpose ___Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___Training ___Classification ___Estimation of Proportion
x Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE EIGEN

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / *Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Compute eigenvalues and eigenvectors of a real symmetric matrix.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: SYSTEM/360 SSP and
"Mathematical Methods for Digital Computers," Vol. 1, Edited by A. Ralston and H.S. Wilf, John Wiley and Sons, N.Y., 1962, Chapt. 7.
Description:
Implements the Jacobi diagonalization method as adapted by Von Neumann

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

I. NAME: SUBROUTINE DFMFP

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To find a local minimum of a function of several variables.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: R. Fletcher and M.J.P.Powell, A rapidly convergent descent method for minimization, Comp. J. 6(1963), 163-168.

Description:
Uses a deflected gradient procedure to determine a local minimum of a function of several variables. Requires analytical expressions for gradient.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:
FUNCT - A user supplied routine which computes the objective function and gradient.

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
x Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE FUNCT

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Compute the probability of misclassification and its gradient with respect to a vector

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: LFSPMC

Description: Uses analytical variational equations and closed form expressions for the probability of misclassification to compute functional values and gradient vector for optimization package

VI. SPECIAL FEATURES: Has variable dimensioning

VII. SUBROUTINES REQUIRED: XNDF, DPHI, DERF

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
x Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: FUNCTION XNDF

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Evaluate one-dimensional normal density function with mean XMU and variance SIG at a point A.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: LFSPMC:Linear Feature Selection Program Using the Probability of Misclassification

Description: $XNDF(A,XMU,SIG)=(2\pi)^{-1/2}(SIG)^{-1/2}EXP\left(-\frac{1}{2}\ \frac{(A-XMU)^2}{SIG}\right)$

VI. SPECIAL FEATURES: Sets XNDF(A,XMU,SIG)=0 if argument in EXP is less than -175

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available __Not Available __Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is __Is not x compatible with Image 100 configuration in present form

__Non-PDP 11/45 FORTRAN

__Some machine language conversion necessary

__In language other than FORTRAN. Specify _____

__Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose __Special purpose __Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

__Training __Classification __Estimation of Proportion

x Feature Selection __Signature Extension

__Temporal Sampling __Systems Development __Technique Development

__Crop Assessment __Yield Estimation

__Other (specify) _____

I. NAME: SUBROUTINE DERF

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: To evaluate the error function of a variable X.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: $\mathrm{DERF}(X) = (2\pi)^{-1/2} \int_{-a}^{X} \mathrm{EXP}\left(\frac{-t^2}{2}\right) dt$

VI. SPECIAL FEATURES: Has additional entry point DPHI to compute

$$\mathrm{DPHI}\ (X) = .5 + .5\ (\mathrm{DERF}(X/\sqrt{2}))$$

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE
___ Training x Classification ___ Estimation of Proportion
x Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE CLSNEW

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Classify labeled measurement vectors using the B vector and associated decision regions previously determined by the minimization procedure

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: LFSPMC

Description: Each measurement vector is classified by first forming its inner product with the optimal B vector and then choosing the decision region of the result. An error matrix is built to record correct/incorrect classifications.

VI. SPECIAL FEATURES: Each vector, its label, and assigned class may be output by setting appropriate option flags.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not x compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose x Special purpose ___ Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

x Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE ERRMAT

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Computes and outputs estimated confusion matrix based on the error matrix generated by the classification routine

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: LFSPMC

Description: The ij^{th} entry pij in the confusion matrix is the estimated probability that something in class j is classified into class i.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification x Estimation of Proportion
x Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE RANCLN

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marlon

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Generate and classify random vectors according to original class statistics to estimate probability of misclassification in the original feature space

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: LFSPMC

Description: Mean vector and covariance matrix for each class are used to produce random n-dimensional vectors. Each such vector is classified (Bayesian classifier) and a confusion matrix is estimated.

VI. SPECIAL FEATURES: Variable dimensioned

VII. SUBROUTINES REQUIRED: MCHLSK, GAUSS

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not x compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose ___ Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

___ Training x Classification x Estimation of Proportion

x Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE MCHLSK

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Compute the modified Cholesky decomposition of the covariance matrix.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: V.I. Van Rooy, M.S. Lynn, C.H. Snyder, ICSA Report No-275-025-008, Institute for Computer Services and Applications, Rice University, Houston, Texas.
Description: Uses a modified method of Cholesky to decompose a positive definite symmetric matrix into upper and lower triangular matrices.

VI. SPECIAL FEATURES: The decompositions overlay the elements of the original matrix.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE GAUSS

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Compute a normally distributed random number of mean zero and covariance one.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: System/360 Scientific Subroutine Package, Version III, 5th Edition Form GH20-0205-4, International Business Machines, August, 1970.
Description: Twelve uniformly distributed random numbers on the interval 0 to 1 are added, giving a random number approximately normally distributed about 6; then 6 is subtracted, giving the desired result.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: RANDU

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification ___ Estimation of Proportion
x Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE RANDU

II. SOURCE (include coder/person with knowledge of program usage):
L.F. Guseman, Jr. / Bruce Marion

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/65

IV. PURPOSE: Compute a uniformly distributed random number between zero and one.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: System/360 Scientific Subroutine Package, Version III, 5th Edition, Form GH20-0205-4, International Business Machines, August, 1970.
Description:

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not x compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification ___ Estimation of Proportion
x Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

COMPUTER PROGRAM IDENTIFICATION FORM

THIS FORM PREPARED BY LEC

I. NAME: CANONICAL

II. SOURCE (include coder/person with knowledge of program usage):
Walter Eppler

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: IBM 360/75

IV. PURPOSE: Too classify multispectral data.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See next page

Description: See next page

VI. SPECIAL FEATURES: See next page

VII. SUBROUTINES REQUIRED: None

VIII. DOCUMENTATION: __Available __Not Available _x_ Will be Available

IX. _x_ Software available off-the-shelf. Approximate Cost: _0_
Is _x_ Is not __ compatible with Image 100 configuration in present form
_x_ Non-PDP 11/45 FORTRAN
__ Some machine language conversion necessary
__ In language other than FORTRAN. Specify _____
__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
_x_ General purpose __ Special purpose __ Program package
__ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: __ LACIE __ Non-LACIE
_x_ Training _x_ Classification __ Estimation of Proportion
_x_ Feature Selection __ Signature Extension
__ Temporal Sampling __ Systems Development __ Technique Development
__ Crop Assessment __ Yield Estimation
__ Other (specify) _____

CANONICAL ANALYSIS FOR INCREASED CLASSIFICATION SPEED AND CHANNEL SELECTION

Walter Eppler
Lockheed Electronics Company

Kenneth Baker
NASA Johnson Space Center

1. Introduction

The well-known classification rule based on the maximum-likelihood criterion and assumed normal probability density functions involves evaluating quadratic forms in the case of M classes. Sometimes a linear transformation is performed on the original N measurements to form $\hat{N} < N$ measurements for use in evaluating the quadratic forms resulting in a reduction in computation time. The disadvantages of this approach are:

1. Additional computer time is required to perform the linear transformations.

2. It is inevitable that some (usually small but unknown) class separability is lost in the dimensionality-reduction.

The algorithm described in this paper has the advantage that it uses only as many channels as necessary to make the desired discriminations; if necessary, all channels are used and no information is sacrificed. Classification speed is achieved by using first those channels which are most important for discrimination. The paper describes how the proper order is determined; the derivation has obvious application in the general area of channel-selection. Empirical results are presented to show the optimum channel-order and resulting increase in classification speed in typical applications.

D. PATTERN RECOGNITION LIBRARY

4. ESTIMATION OF PROPORTION PACKAGE

A package which estimates proportions by using maximum likelihood, method of moments, estimated confusion matrix, and classification is being documented by Dr. Bill Coberly (currently at the University of Houston).

I. NAME: SUBROUTINE APREST - ESTIMATION OF PROPORTION PACKAGE

II. SOURCE (include coder/person with knowledge of program usage):
L. F. Guseman, Jr./Bruce Marion, Department of Mathematics, TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: To estimate the proportion of each of m classes from a set of random observation vectors.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: L. F. Guseman, Jr. and Bruce Marion, A method for estimating proportions, Contract NAS-9-13894-1S, Report #4, Dept. of Math., Texas A&M University, April 1975.
Description: Given a classification procedure, its associated confusion matrix, and a set of random observation vectors selected from among m classes, the vector of proportions for the classes is estimated.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: LSI, AWNW

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose x Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification x Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE LSI

II. SOURCE (include coder/person with knowledge of program usage):
L. F. Guseman, Jr./Bruce P. Marion, Dept. Math., TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: To solve the least squares problem with inequality constraints(LSI):
minimize $||Ex-u||$ subject to $x \geq 0$, $\Sigma x_i = 1$

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: C. L. Lawson and R. J. Hanson, Solving Least Squares Problems, Prentice-Hall, 1974, Chapter 23.

Description: Converts LSI into least distance problem (LDP).

VI. SPECIAL FEATURES: Checks for singular E (assumed square).

VII. SUBROUTINES REQUIRED: SVDM, LDP

VIII. DOCU[illegible]ATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification x Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE SVDM

II. SOURCE (include coder/person with knowledge of program usage):
G. H. Golub, Computer Science Dept., Stanford Univ., Stanford, Ca. 94305

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 1108, 360/65, CDC6600
ALGOL 60

IV. PURPOSE:
Singular value decomposition of rectangular matrix

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: G. H. Golub and C. Reinsch, "Singular value decomposition and least squares solutions," Numer. Math 14(1970), pp. 403-421.

Description:
Decompose a given matrix A into matrices U,S,V such that
$A = U * S * V^T$

VI. SPECIAL FEATURES:
Modification of SUBROUTINE DSVD.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training x Classification x Estimation of Proportion
x Feature Selection x Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE LDP

II. SOURCE (include coder/person with knowledge of program usage):
L. F. Guseman, Jr./Bruce D. Marion, Dept. of Math., TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: To solve the least distance problem (LDP): minimize $||g||$
subject to $Ag \geq w$

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See LSI

Description: Converts LDP into nonnegative least squares problem (NNLS).

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: NNLS

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
x General purpose ___ Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification x Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE NNLS

II. SOURCE (include coder/person with knowledge of program usage):
L. F. Guseman, Jr./Bruce P. Marion, Dept. Math., TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: To solve the nonnegative least squares problem (NNLS):

minimize $||Cz-v||$ subject to $z \geq 0$.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See LSI

Description: Given an $m \times n$ matrix C, and an m-vector v, compute an n-vector z with nonnegative entries which minimizes $||Cz-v||$.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: H12, G1, G2, DIFF

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-

Is x Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

x General purpose ___ Special purpose ___ Program package

x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE

___ Training ___ Classification x Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development x Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: SUBROUTINE H12

II. SOURCE (include coder/person with knowledge of program usage):
L. F. Guseman, Jr./Bruce P. Marion, Dept. Math., TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: Construct and apply a Householder Transformation:

$$Q = I + U(U^T)/B$$

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See LSI

Description: Given m-vector v and integers l_p and l_1, computes m-vector u and S such that symmetric orthogonal matrix $A = I + (uu^T)/(SU_1)$ satisfies $Q_v = w$.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification x Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE G1

II. SOURCE (include coder/person with knowledge of program usage):
L. F. Guseman, Jr./Bruce P. Marion, Dept. of Math., TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: Construction and application of rotation matrices

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See LSI

Description: Given c, s, z_1, z_2, computes

$$G \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \equiv \begin{pmatrix} c & s \\ -s & c \end{pmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: -?-
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification x Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: SUBROUTINE G2

II. SOURCE (include coder/person with knowledge of program usage):
L. F. Guseman, Jr./Bruce F. Marion, Dept. Math., TAMU

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/65

IV. PURPOSE: Construction and application of rotation matrices.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See LSI

Description: Applies the rotation computed by G1 to x_1, x_2 :

$$\begin{pmatrix} z_1 \\ z_2 \end{pmatrix} = G \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___Not Available ___Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___General purpose x Special purpose ___Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___Training ___Classification x Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development x Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

I. NAME: SUBROUTINE DIFF

II. SOURCE (include coder/person with knowledge of program usage):
L. F. Guseman, Jr./Bruce P. Marion, Dept. Math., TAMU

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: 360/65

IV. PURPOSE: To test "IF((x+h)-x) ≠ 0

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: See LSI

Description: The intermediate sum z = x+h is computed in the calling program using n precision arithmetic. The difference z-x is computed by this function using n precision arithmetic.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: x Available ___ Not Available ___ Will be Available

IX. x Software available off-the-shelf. Approximate Cost: _____
Is x Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose x Special purpose ___ Program package
x PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: x LACIE x Non-LACIE
___ Training ___ Classification x Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development x Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: PROPORTION ESTIMATION PACKAGE

II. SOURCE (include coder/person with knowledge of program usage):
W. A. Coberly, Dept. of Math. Sci., U. of Tulsa

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER:360/75

IV. PURPOSE: Compute proportion estimates for use in acreage estimation.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: "An empirical comparison of five proportion estimates," Coberly and Odell, NASA/JSC Tech. Report, 1974, U. of Texas at Dallas.

Description:

VI. SPECIAL FEATURES: Five seperate driver programs

VII. SUBROUTINES REQUIRED:

Main		Subroutines	
	*CLASS	*MIXTUR	MINV
	*MXLIKE	*MOMENT	PREP
	*CONF		QUADPR

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose X Special purpose X Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: ___ LACIE ___ Non-LACIE

___ Training ___ Classification X Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development ___ Technique Development

___ Crop Assessment ___ Yield Estimation

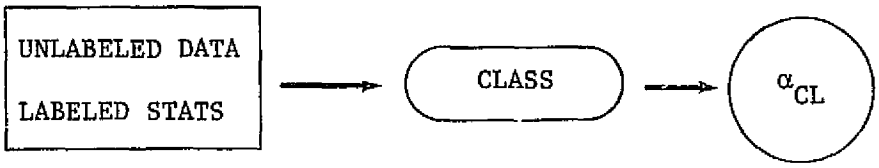
___ Other (specify) _____

DATA PRODUCTS REQUIRED

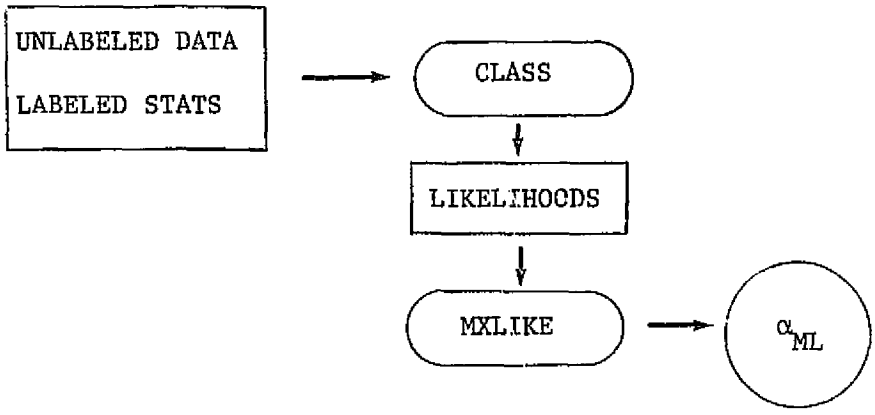
1. Unlabeled (recognition) data set in intermediate format (vector by vector).
2. Test data set in above format.
3. Labeled (training) statistics.
4. Histograms of labeled data.
5. Unlabeled statistics.
6. Histograms of unlabeled data.

DATA FLOW

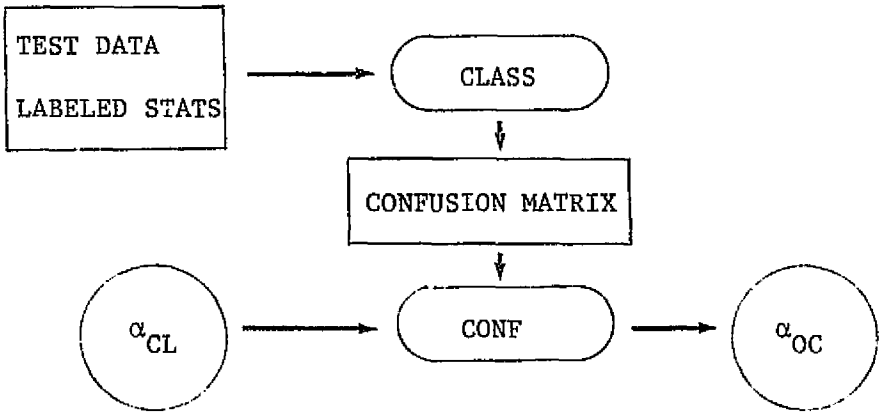
1. Classification estimator (α_{CL}) .



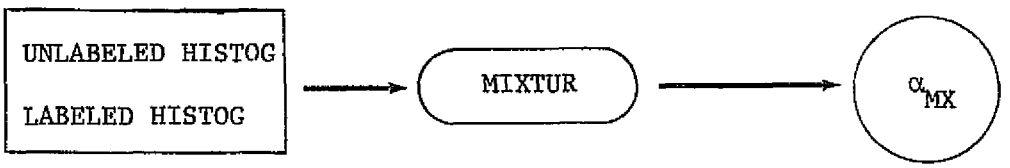
2. Maximous likelihood estimate (α_{ML}) .



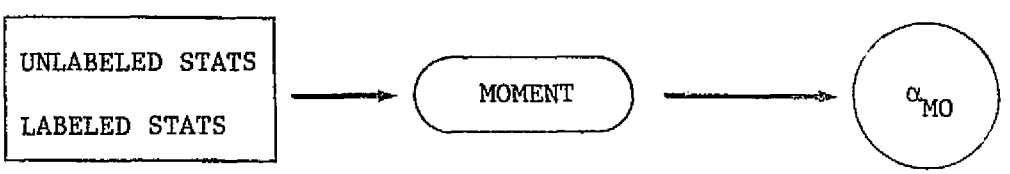
3. Odell-Chhikara confusion matrix estimate (α_{OC})



4. Minimum Chi-square estimate (α_{MX})



5. Moment estimate (α_{MO})



I. NAME: CLASS

II. SOURCE (include coder/person with knowledge of program usage):
W. A. Coberly, Dept. of Math., U. of Tulsa

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: 360/75

IV. PURPOSE: Classify observation vectors (pixels)

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: "An empirical comparison of five proportion estimates," Coberly and Odell, NASA/JSC Tech. Report 1974, U. of Texas at Dallas

Description:
Maximum likelihood classification rule

VI. SPECIAL FEATURES: Inputs are training signatures and unlabeled data. The likelihoods may be saved on temporary disk storage.

VII. SUBROUTINES REQUIRED: MINV

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. _X_ Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose _X_ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: _X_ LACIE _X_ Non-LACIE
___ Training ___ Classification ___ Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: MXLIKE

II. SOURCE (include coder/person with knowledge of program usage):
W. A. Coberly, Dept. of Math., U. of Tulsa

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/75

IV. PURPOSE: Maximum likelihood solution of proportions. (Fixed signatures)

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: "The Numerical evaluations of maximum-likelihood estimate of mixture proportions," Peters and Coberly NASA/JSC Tech. Report, 1975, UTD.

Description:
Iteration scheme for finding maximum likelihood estimates of proportions.

VI. SPECIAL FEATURES: Uses output of likelihoods for each from CLASS, stored in a temporary disk file.

VII. SUBROUTINES REQUIRED: NONE

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose X Special purpose ___ Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE ___ Non-LACIE

___ Training ___ Classification ___ Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development X Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: CONF

II. SOURCE (include coder/person with knowledge of program usage):
W. A. Coberly, Dept. of Math., U. of Tulsa

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/75

IV. PURPOSE: Proportion estimation by Odell-Chhikara method using the confusion matrix.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: "An empirical comparison of five proportion estimates," Coberly and Odell, NASA/JSC Tech. Report, 1974, UTD.

Description: Finds constrained solution of the equation

$\hat{\alpha} = P\alpha$ where $\hat{\alpha}$ is the classification estimate of the proportions and P is the confusion matrix.

VI. SPECIAL FEATURES: The confusion matrix P is estimated by the classification of test data.

VII. SUBROUTINES REQUIRED: QUADPR, PREP

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose X Special purpose ___ Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE ___ Non-LACIE

___ Training ___ Classification X Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development X Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: MIXTUR

II. SOURCE (include coder/person with knowledge of program usage):
W. A. Coberly, Dept. of Math., U. of Tulsa

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/75

IV. PURPOSE: Proportion estimation by method of minimum chi-square.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: "An empirical comparison of five proportion estimates," Coberly, Odell, NASA/JSC, Tech. Report, 1974, UTD.

Description: Constrained least squares solution of system found by equating the percentiles of the marginal mixture distributions.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: QUADPR, PREP

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
___ General purpose X Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE ___ Non-LACIE
___ Training ___ Classification X Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development X Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: MØMENT

II. SOURCE (include coder/person with knowledge of program usage):
W. A. Coberly, Math. Dept, U. of Tulsa

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/75

IV. PURPOSE: Proportion estimation by method of moments.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: "An empirical comparison of five proportion estimates," Coberly, Odell, NASA Tech. Report 1974, U. of Texas at Dallas

Description: Constrained weighted least square solution of mixture moment equations.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: QUADPR, PREP

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. ___ Software available off-the-shelf. Approximate Cost: _____

Is ___ Is not ___ compatible with Image 100 configuration in present form

___ Non-PDP 11/45 FORTRAN

___ Some machine language conversion necessary

___ In language other than FORTRAN. Specify _____

__ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL

___ General purpose X Special purpose ___ Program package

___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE ___ Non-LACIE

___ Training ___ Classification X Estimation of Proportion

___ Feature Selection ___ Signature Extension

___ Temporal Sampling ___ Systems Development X Technique Development

___ Crop Assessment ___ Yield Estimation

___ Other (specify) _____

I. NAME: QUADPR

II. SOURCE (include coder/person with knowledge of program usage):
W. A. Coberly, Dept. of Math., U. of Tulsa

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/75

IV. PURPOSE: Constrained quadratic programming scheme (Wolfe)

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: "Optimization techniques with FORTRAN," Kuester and Mize, McGraw Hill, pp. 106-119.

Description: Quadratic programming routine used to solve constrained least squares problems.

VI. SPECIAL FEATURES: Does not handle singular quadratic objective functions.

VII. SUBROUTINES REQUIRED: None

VIII. DOCUMENTATION: X Available ___ Not Available ___ Will be Available

IX. X Software available off-the-shelf. Approximate Cost: _____
Is ___ Is not ___ compatible with Image 100 configuration in present form
___ Non-PDP 11/45 FORTRAN
___ Some machine language conversion necessary
___ In language other than FORTRAN. Specify _____
___ Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
X General purpose ___ Special purpose ___ Program package
___ PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE ___ Non-LACIE
___ Training ___ Classification X Estimation of Proportion
___ Feature Selection ___ Signature Extension
___ Temporal Sampling ___ Systems Development ___ Technique Development
___ Crop Assessment ___ Yield Estimation
___ Other (specify) _____

I. NAME: PREP

II. SOURCE (include coder/person with knowledge of program usage):
W. A. Coberly, Dept. of Math., U. of Tulsa

III. PROGRAMMING LANGUAGE: FORTRAN IV COMPUTER: IBM 360/75

IV. PURPOSE: Prepare objective function from a system of linear equations for input to QUADPR.

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference:

Description: Constructs quadratic objective function for constrained least square solution by Wolfe's method.

VI. SPECIAL FEATURES:

VII. SUBROUTINES REQUIRED: NONE

VIII. DOCUMENTATION: [X] Available [ ] Not Available [ ] Will be Available

IX. [ ] Software available off-the-shelf. Approximate Cost: _____
Is [ ] Is not [ ] compatible with Image 100 configuration in present form
[ ] Non-PDP 11/45 FORTRAN
[ ] Some machine language conversion necessary
[ ] In language other than FORTRAN. Specify _____
[ ] Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
[X] General purpose [ ] Special purpose [ ] Program package
[ ] PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: [X] LACIE [ ] Non-LACIE
[ ] Training [ ] Classification [X] Estimation of Proportion
[ ] Feature Selection [ ] Signature Extension
[ ] Temporal Sampling [ ] Systems Development [ ] Technique Development
[ ] Crop Assessment [ ] Yield Estimation
[ ] Other (specify) _____

I. NAME: MINV

II. SOURCE (include coder/person with knowledge of program usage):
W. A. Coberly, Dept. of Math., U. of Tulsa

III. PROGRAMMING LANGUAGE: FORTRAN COMPUTER: 360/75

IV. PURPOSE: Invert a matrix

V. ALGORITHM/TECHNIQUE (short description; include reference if available)

Reference: IBM SSP-III Manual

Description: An elementary Gaussian elimination routine

VI. SPECIAL FEATURES: A routine inverting only a symmetric positive-definite covariance matrix is required.

VII. SUBROUTINES REQUIRED:

VIII. DOCUMENTATION: X Available ___Not Available ___Will be Available

IX. X Software available off-the-shelf. Approximate Cost: -0-
Is ___Is not ___compatible with Image 100 configuration in present form
___Non-PDP 11/45 FORTRAN
___Some machine language conversion necessary
___In language other than FORTRAN. Specify _____
___Software must be designed and developed for Image 100

X. IMPLEMENTATION LEVEL
X General purpose ___Special purpose ___Program package
___PDP 11/45 FORTRAN LIBRARY FUNCTION OR SUBROUTINE

XI. APPLICATION: X LACIE ___Non-LACIE
___Training ___Classification X Estimation of Proportion
___Feature Selection ___Signature Extension
___Temporal Sampling ___Systems Development ___Technique Development
___Crop Assessment ___Yield Estimation
___Other (specify) _____

D. PATTERN RECOGNITION LIBRARY

5. SPATIAL PATTERN RECOGNITION PACKAGE

D. PATTERN RECOGNITION LIBRARY

6. SIGNATURE EXTENSION PACKAGE

A program is being developed at the University of Houston to perform signature extension using the maximum likelihood function. A similar, but more specialized, algorithm for signature extension is being implemented by LEC. A specialized version of the LEC algorithm is being studied by ERIM (MASC Algorithm). An additional signature extension technique is being developed by Dr. Ungar at GFSC (no details available).

IMPLEMENTATION PRIORITY SUMMARY

The following is a summary by package of those subroutines and programs for which identification forms have been completed. Each program was assigned one of the implementation priorities defined in Section IV and repeated below for ease of reference.

Priority I - Basic utility subroutine or program required for the implementation of existing image analysis techniques

Priority II - Existing image analysis techniques (requires majority of Priority I items)

Priority III - Subroutine or program required to support development and/or refinement of image analysis techniques

Priority IV - Image analysis techniques in research and development stage.

PROGRAM	PRIORITY
A. PRE-ANALYSIS DATA PROCESSING LIBRARY	
1. PREPROCESSING PACKAGE	
GENERAL RADIOMETRIC CORRECTION (G.E.)	I
2. REGISTRATION PACKAGE	
SUBROUTINE CORLAT	II
SUBROUTINE REGSTR	II
3. TRAINING FIELD SELECTION PACKAGE	
IRREGULARLY-SHAPED FIELDS	I
LINE FIND ROUTINE	I
GREY SCALE MAP PACKAGE	IV
KONTUR PACKAGE	IV
4. SIMULATED DATA GENERATOR PACKAGE	

PROGRAM	PRIORITY
B. GENERAL MATHEMATICAL LIBRARY	
1. LINEAR ALGEBRA PACKAGE	
SUBROUTINE MINVSP	I
SUBROUTINE MINVDP	I
LU-Decomposition Package	I
SUBROUTINE GINV2M	I
SUBROUTINE CHLSKY	I
TSTMIS (single precision)	I
TSTMID (double precision)	I
SUBROUTINE SEIGEN	I
SUBROUTINE DSVD	I
SUBROUTINE MATMUL	I
SUBROUTINE EIGEN	I
2. OPTIMIZATION PACKAGE	
SUBROUTINE DFMFP	I
SUBROUTINE FRKWLF	I
SUBROUTINE QM431	I
SUBROUTINE LSI	I
3. APPROXIMATION PACKAGE	
Basic Spline Routines--Single Variable	I
4. TRANSFORM PACKAGE	
(MSFAR) Multispectral Fourier Analysis Routines	III

PROGRAM	PRIORITY

C. GENERAL STATISTICAL LIBRARY

1. STATISTICAL SUMMARY PACKAGE

SUBROUTINE MECOV	
SUBROUTINE GROP1	I
SUBROUTINE MEDIAN	I
SUBROUTINE MODE	I
SUBROUTINE RANGE	I
SUBROUTINE MNDEV	I
SUBROUTINE SDEV	I
SUBROUTINE ORDER	I
PLOT PAC	I
BINARY SEARCH/N-DIMENSION HISTOGRAM ACQUISITION (G.E.)	I

2. DENSITIES & DISTRIBUTIONS PACKAGE

FUNCTION PHINV (P)	I
DOUBLE PRECISION FUNCTION DPHI	I
REAL FUNCTION FISH	I
DOUBLE PRECISION FUNCTION DERF	I
SINGLE PRECISION FUNCTION ERF	I
DOUBLE PRECISION FUNCTION DERFC	I
SINGLE PRECISION FUNCTION ERFC	I
REAL FUNCTION CHI2	I
FUNCTION EXPAN	I
REAL FUNCTION POSI	I
FUNCTION FISHIN	I
REAL FUNCTION BIN	I
FUNCTION HYTRIC	I
REAL FUNCTION BETINC	I
REAL FUNCTION GAMIN	I
REAL FUNCTION STUDIN	I
REAL FUNCTION ZOT	I
FUNCTION RANDOM	I
REAL FUNCTION ZIP	I
REAL FUNCTION ZARF	I
FUNCTION KPSNSM	I
SUBROUTINE BIN2	I
SUBROUTINE OVERFL(I)	I

3. REGRESSION PACKAGE

4. STATISTICAL TESTS

SUBROUTINE TTEST	I
SUBROUTINE CØVARI	I
SUBROUTINE ANOV1	I
SUBROUTINE ANOVA2	I
SUBROUTINE RBANOV	I
FUNCTION ZOR	I
SUBROUTINE KOLSMR	I
SUBROUTINE FACTOR	I

PROGRAM	PRIORITY
D. PATTERN RECOGNITION LIBRARY	
1. CLUSTERING PACKAGE	
SEMI-SUPERVISED CLUSTER ANALYSIS (G.E.)	II
ISOCLS Routines	II
2. CLASSIFICATION PACKAGE	
ELLTAB	I
MAXIMUM LIKELIHOOD RESOLUTION (G.E.)	I
3. FEATURE SELECTION PACKAGE	
UH Linear Feature Selection	II
LF MC : Linear Feature Selection (PMC)	II
CANONICAL	II
4. ESTIMATION OF PROPORTION PACKAGE	
SUBROUTINE APREST	II
5. SPATIAL PATTERN RECOGNITION PACKAGE	
6. SIGNATURE EXTENSION PACKAGE	